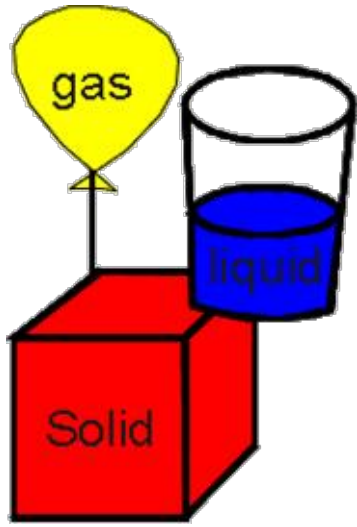
Introduction to Basic Chemistry

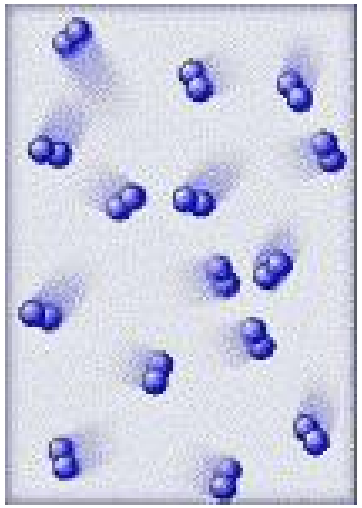
- Matter- anything that has mass (the amount of matter) and occupies space
  - Liquid
  - Solid
  - Gas



- Chemical elements- chemical substances that cannot be broken down into simpler substances by ordinary chemical reactions
- Chemical symbols

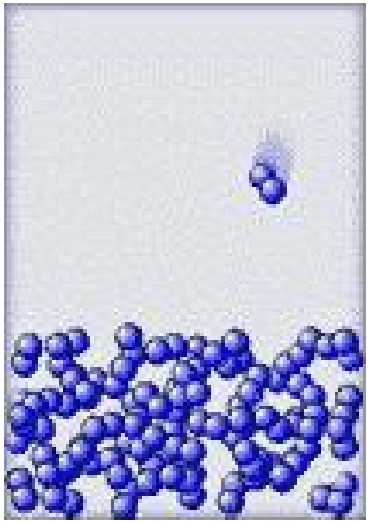
States of Matter

Gas



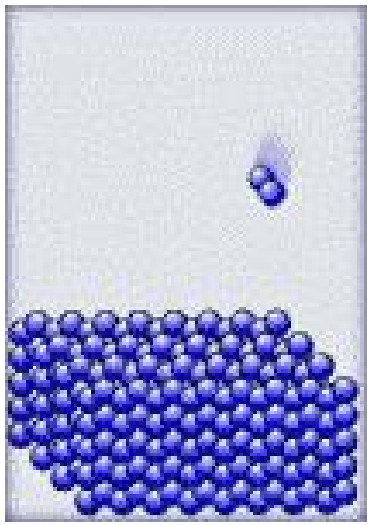
- low density
- easy to expand/compress
- fills container

Liquid



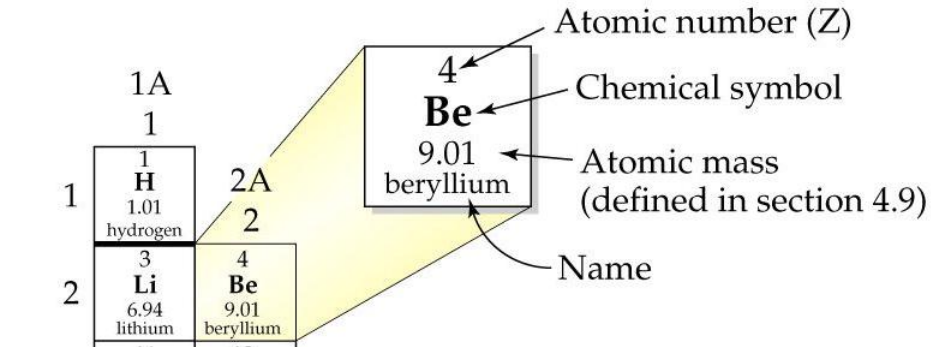
- high density
- hard to expand/compress
- takes shape of container

Solid



- high density
- hard to expand/compress
- rigid shape

Periodic Table



Periods	1A 1	2A 2	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8	8B 9	8B 10	1B 11	2B 12	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
1	1 **H** 1.01 hydrogen																	2 **He** 4.00 helium
2	3 **Li** 6.94 lithium	4 **Be** 9.01 beryllium											5 **B** 10.81 boron	6 **C** 12.01 carbon	7 **N** 14.01 nitrogen	8 **O** 16.00 oxygen	9 **F** 19.00 fluorine	10 **Ne** 20.18 neon
3	11 **Na** 22.99 sodium	12 **Mg** 24.31 magnesium											13 **Al** 26.98 aluminum	14 **Si** 28.09 silicon	15 **P** 30.97 phosphorus	16 **S** 32.07 sulfur	17 **Cl** 35.45 chlorine	18 **Ar** 39.95 argon
4	19 **K** 39.10 potassium	20 **Ca** 40.08 calcium	21 **Sc** 44.96 scandium	22 **Ti** 47.88 titanium	23 **V** 50.94 vanadium	24 **Cr** 52.00 chromium	25 **Mn** 54.94 manganese	26 **Fe** 55.85 iron	27 **Co** 58.93 cobalt	28 **Ni** 58.69 nickel	29 **Cu** 63.55 copper	30 **Zn** 65.39 zinc	31 **Ga** 69.72 gallium	32 **Ge** 72.61 germanium	33 **As** 74.92 arsenic	34 **Se** 78.96 selenium	35 **Br** 79.90 bromine	36 **Kr** 83.80 krypton
5	37 **Rb** 85.47 rubidium	38 **Sr** 87.62 strontium	39 **Y** 88.91 yttrium	40 **Zr** 91.22 zirconium	41 **Nb** 92.91 niobium	42 **Mo** 95.94 molybdenum	43 **Tc** (99) technetium	44 **Ru** 101.07 ruthenium	45 **Rh** 102.91 rhodium	46 **Pd** 106.42 palladium	47 **Ag** 107.87 silver	48 **Cd** 112.41 cadmium	49 **In** 114.82 indium	50 **Sn** 118.71 tin	51 **Sb** 121.75 antimony	52 **Te** 127.60 tellurium	53 **I** 126.90 iodine	54 **Xe** 131.29 xenon
6	55 **Cs** 132.91 cesium	56 **Ba** 137.33 barium	57 **La** 138.91 lanthanum	72 **Hf** 178.49 hafnium	73 **Ta** 180.95 tantalum	74 **W** 183.85 tungsten	75 **Re** 186.21 rhenium	76 **Os** 190.2 osmium	77 **Ir** 192.22 iridium	78 **Pt** 195.08 platinum	79 **Au** 196.97 gold	80 **Hg** 200.59 mercury	81 **Tl** 204.38 thallium	82 **Pb** 207.2 lead	83 **Bi** 208.98 bismuth	84 **Po** (209) polonium	85 **At** (210) astatine	86 **Rn** (222) radon
7	87 **Fr** (223) francium	88 **Ra** (226) radium	89 **Ac** (227) actinium	104 **Rf** (261) rutherfordium	105 **Db** (262) dubnium	106 **Sg** (263) seaborgium	107 **Bh** (262) bohrium	108 **Hs** (265) hassium	109 **Mt** (266) meitnerium	110 (269)	111 (272)	112 (277)		114 (285)		116 (289)		

Lanthanides	58 **Ce** 140.12 cerium	59 **Pr** 140.91 praseodymium	60 **Nd** 144.24 neodymium	61 **Pm** (147) promethium	62 **Sm** 150.36 samarium	63 **Eu** 151.97 europium	64 **Gd** 157.25 gadolinium	65 **Tb** 158.93 terbium	66 **Dy** 162.50 dysprosium	67 **Ho** 164.93 holmium	68 **Er** 167.26 erbium	69 **Tm** 168.93 thulium	70 **Yb** 173.04 ytterbium	71 **Lu** 174.97 lutetium
Actinides	90 **Th** (232) thorium	91 **Pa** (231) protactinium	92 **U** (238) uranium	93 **Np** (237) neptunium	94 **Pu** (244) plutonium	95 **Am** (243) americium	96 **Cm** (247) curium	97 **Bk** (247) berkelium	98 **Cf** (251) californium	99 **Es** (252) einsteinium	100 **Fm** (257) fermium	101 **Md** (258) mendelevium	102 **No** (259) nobelium	103 **Lr** (260) lawrencium

Exhibit 2.1 Chemical Elements Found in the Body

CHEMICAL ELEMENT (SYMBOL)	PERCENTAGE OF TOTAL BODY MASS	COMMENT
Oxygen (O)	65.0	Constituent of water and organic molecules (carbon- and hydrogen-containing, made by a living system); needed for cellular respiration, which produces adenosine triphosphate (ATP), an energy-rich chemical in cells.
Carbon (C)	18.5	Found in every organic molecule.
Hydrogen (H)	9.5	Constituent of water, all foods, and most organic molecules; when it is a cation (positively charged ion, H^+), it is an acid.
Nitrogen (N)	3.2	Component of all proteins and nucleic acids. The nucleic acids are deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).
Calcium (Ca)	1.5	Contributes to hardness of bone and teeth; needed for many body processes, for example, blood clotting and contraction of muscle.
Phosphorus (P)	1.0	Component of many proteins, nucleic acids, and adenosine triphosphate (ATP); required for normal bone and tooth structure.
Potassium (K)	0.4	Most abundant cation (K^+) inside cells; important in conduction of nerve impulses and muscle contraction.
Sulfur (S)	0.3	Component of many proteins.
Sodium (Na)	0.2	Most plentiful cation (Na^+) outside cells; essential in blood to maintain water balance; needed for conduction of nerve impulses and muscle contraction.
Chlorine (Cl)	0.2	Most plentiful anion (negatively charged particle, Cl^-) outside cells; essential in blood and interstitial fluid to maintain water balance.
Magnesium (Mg)	0.1	Needed for many enzymes to function properly.
Iodine (I)	0.1	Vital to production of hormones by the thyroid gland.
Iron (Fe)	0.1	Cations (Fe^{2+} and Fe^{3+}) are components of hemoglobin (oxygen-carrying protein in blood) and some enzymes needed for ATP production.
Aluminum (Al), Boron (B), Chromium (Cr), Cobalt (Co), Copper (Cu), Fluorine (F), Manganese (Mn), Molybdenum (Mo), Selenium (Se), Silicon (Si), Tin (Sn), Vanadium (V), Zinc (Zn)		These elements are called **trace elements** because they are present in minute concentrations.

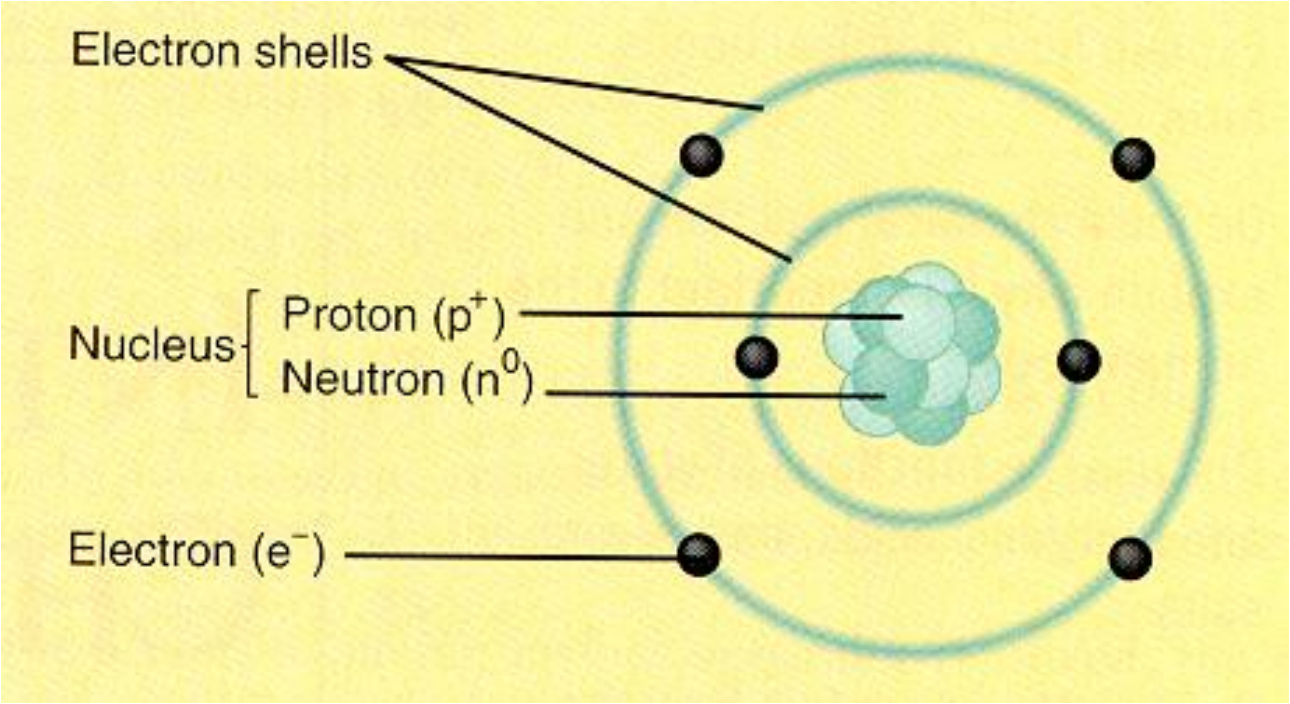
Compose about 96% of total body mass.

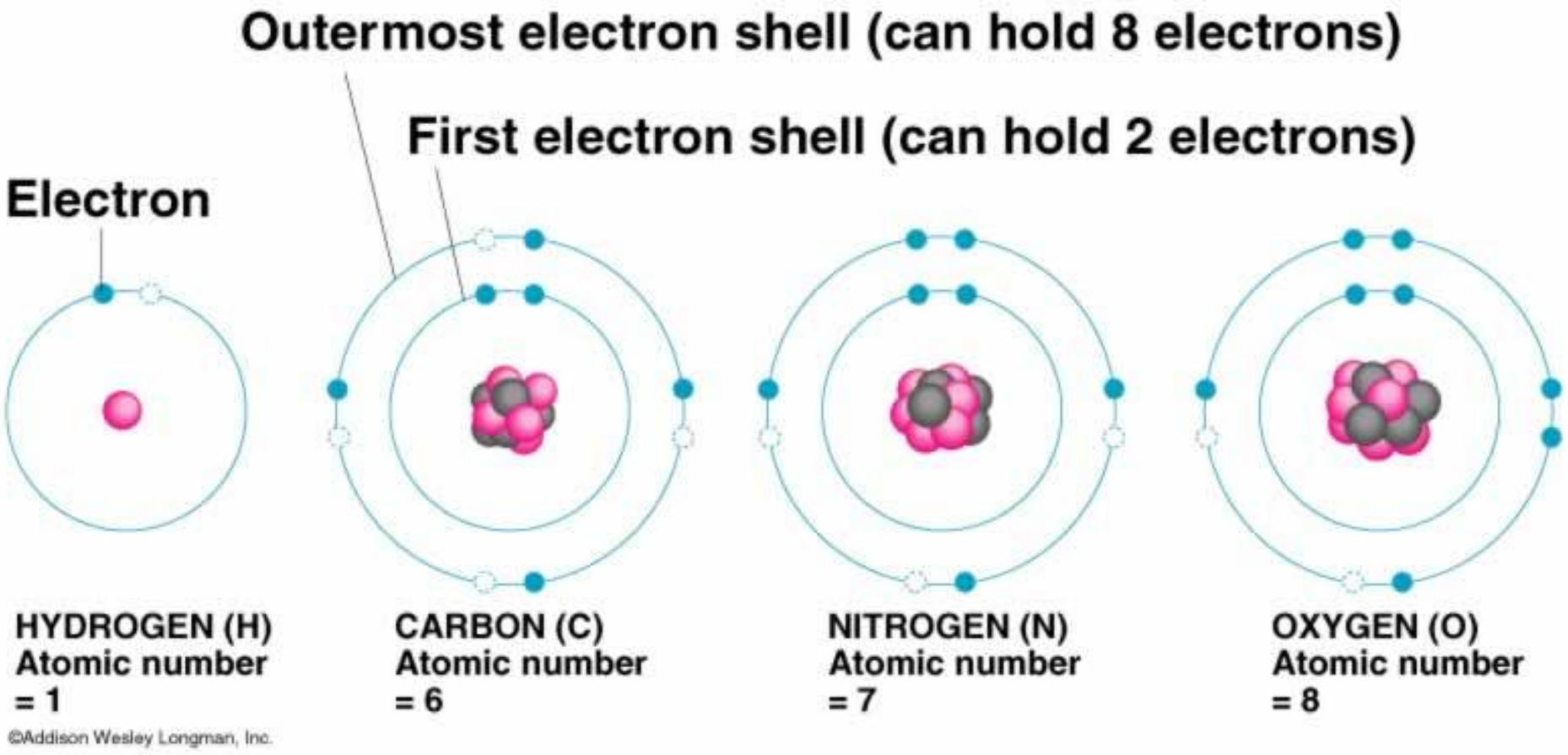
Compose about 3.9% of total body mass.

Compose about 0.1% of total body mass.

Atoms

- All chemical elements are atoms
  - Analogy- all people are classified as humans
    - atom of hydrogen, atom of carbon, etc.
- All atoms have similar structure
  - Analogy- all people have similar body structure




Outermost electron shell (can hold 8 electrons)
First electron shell (can hold 2 electrons)
Electron
HYDROGEN (H)
Atomic number
= 1
CARBON (C)
Atomic number
= 6
NITROGEN (N)
Atomic number
= 7
OXYGEN (O)
Atomic number
= 8
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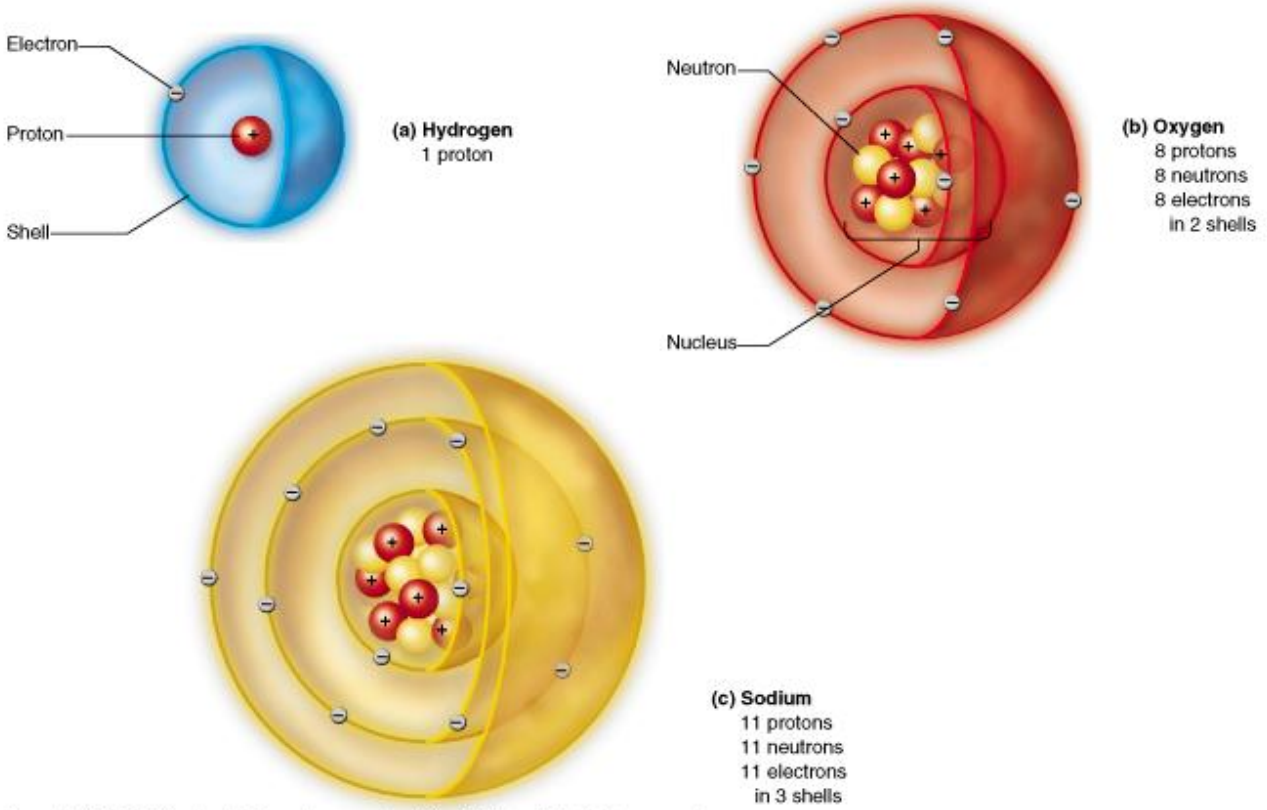
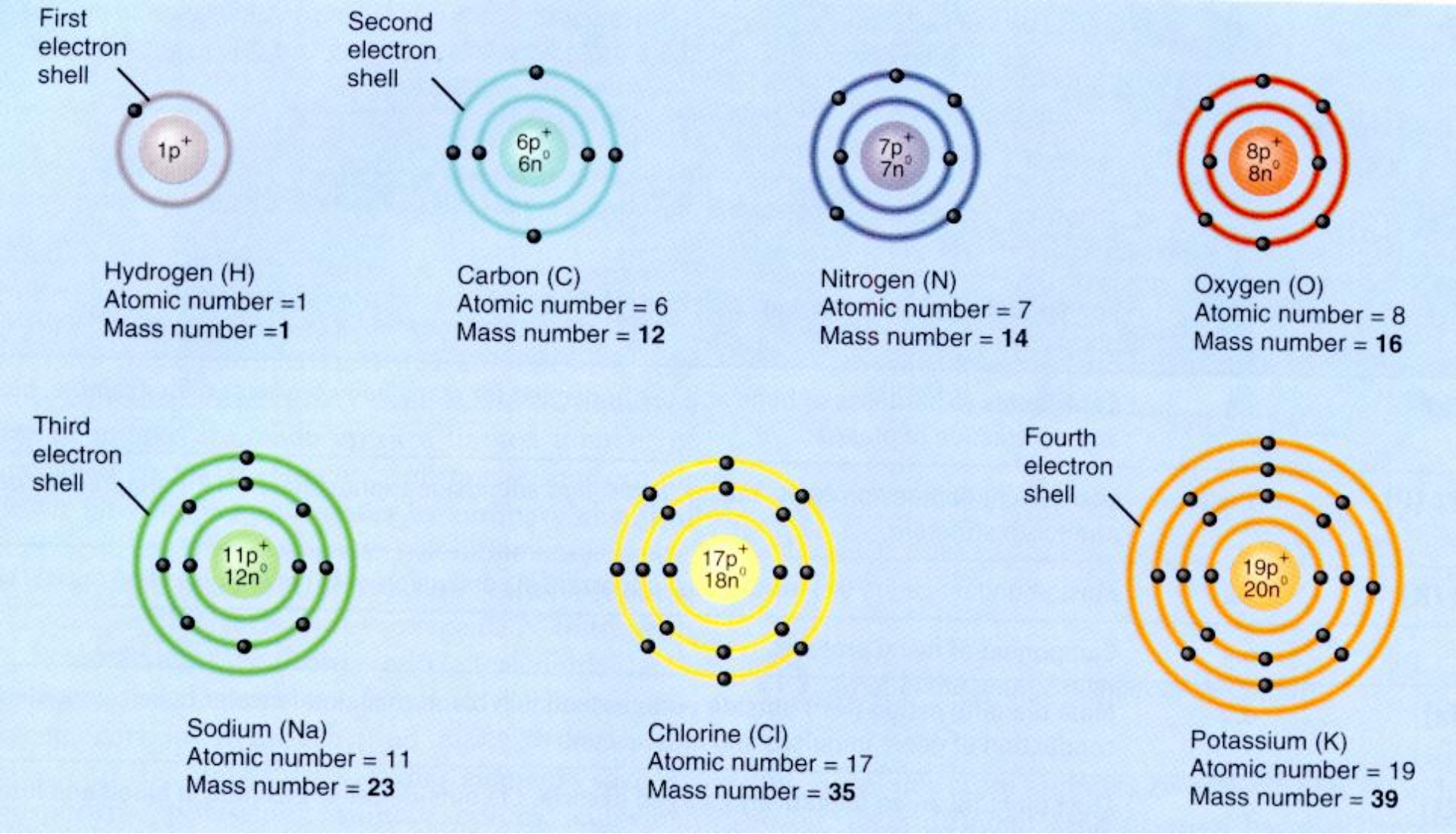
Major Difference Between Atoms

- Number of Protons (atomic number) makes each atom unique in its identity





Atoms, nucleus, proton, neutron, electron, atomic number, valance

Each Atom Will Have a Different Character and Measurable Characteristics

- Weight (atomic mass)
- Attraction of electrons
- Charge
- Stable or unstable (radioactivity)

All these factors determine the type of chemical bonding or interactions with other atoms (elements).

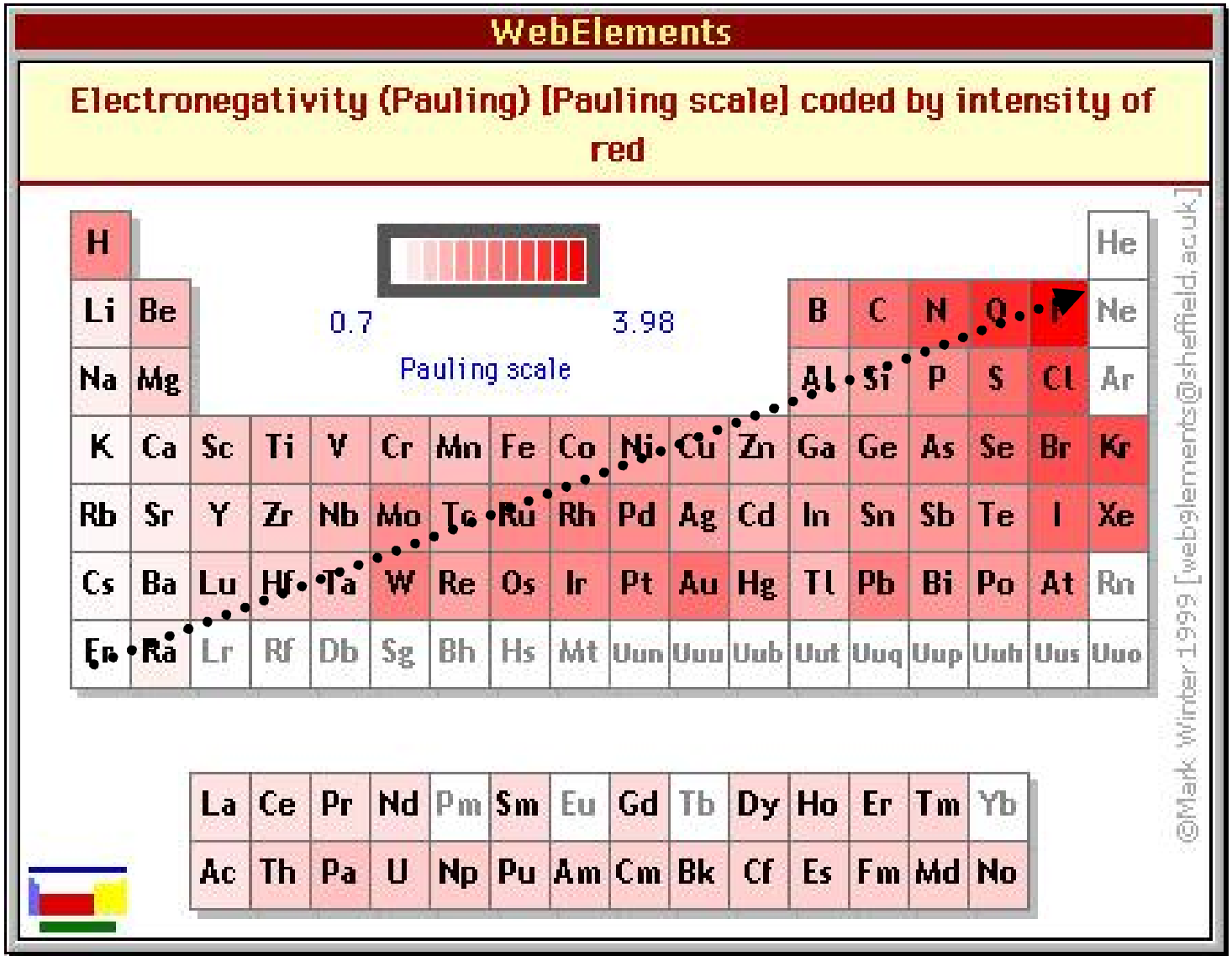
Atomic mass (weight) is the mass of the protons and neutrons not the electrons

If the proton and neutron were enlarged, and each had the approximate mass of a hippopotamus, the electron, enlarged to the same scale, would have less mass than an owl.

Electronegativity

- Refers to the ability of an atom in a molecule to attract shared electrons
- Determines the nature of the chemical bond
  - Ionic
  - Covalent

Ionic Bonds Based of Electronegativity

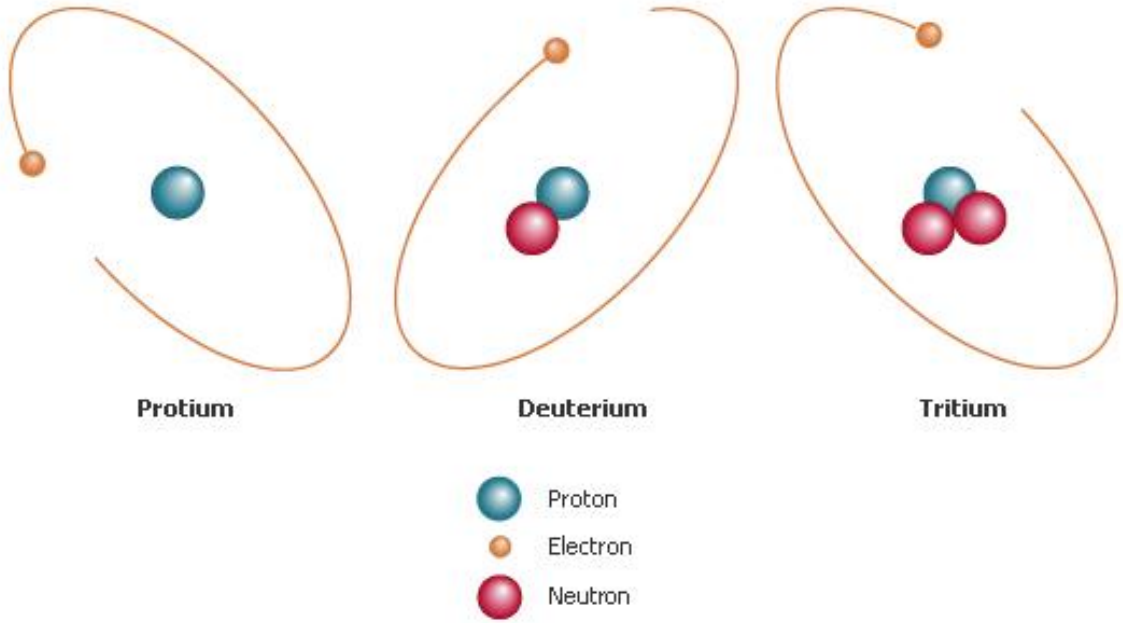


Atomic Charge

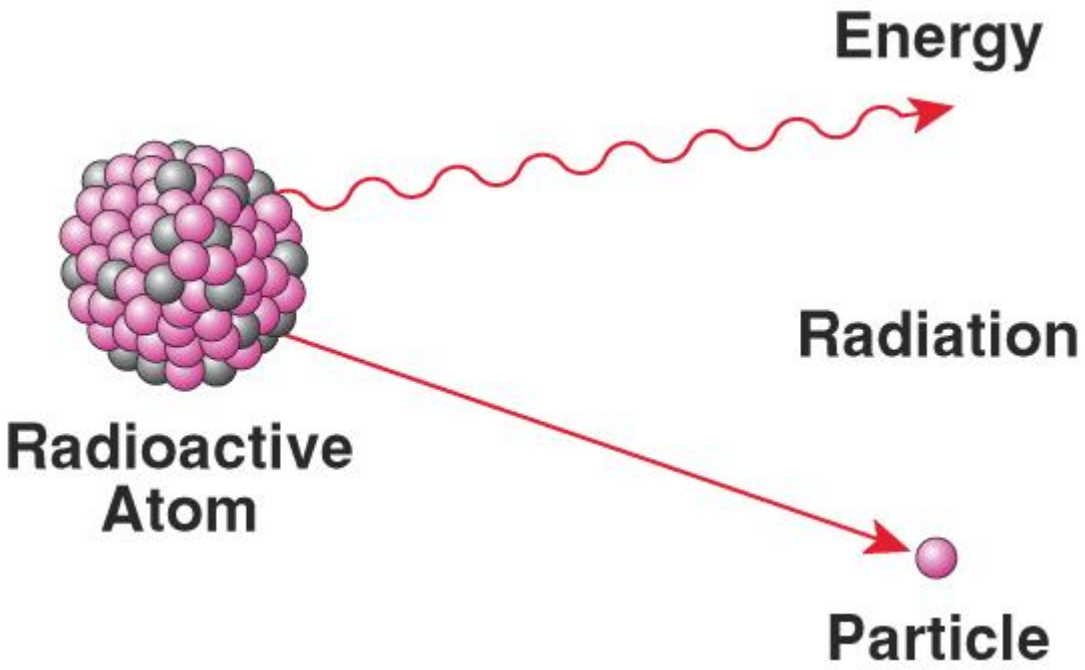
- Determined by the number of electrons in the outer shell (valence)
  - Normal equal numbers of electrons (-) and protons (+)
- Ion- Charged atom of element

Stable or Unstable Atom

- Isotopes- an atom with different numbers of neutrons



Isotopes can be Stable or Unstable

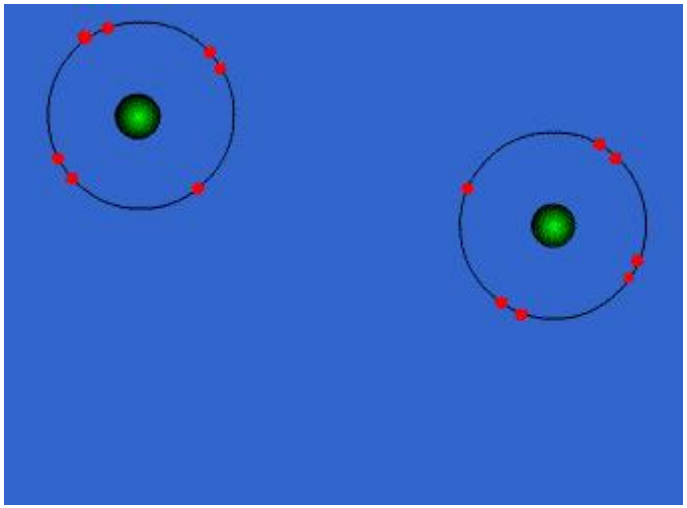


- Unstable isotopes are called radioisotopes

•All matter is made up of atoms of the various elements

•When two or more elements combine in a chemical reaction, the resulting combination is called a **molecule**.

- •A molecule may contain two elements of the
  - •same kind H_2
  - •different H_2O **compound** (two or more elements in a fixed ratio)



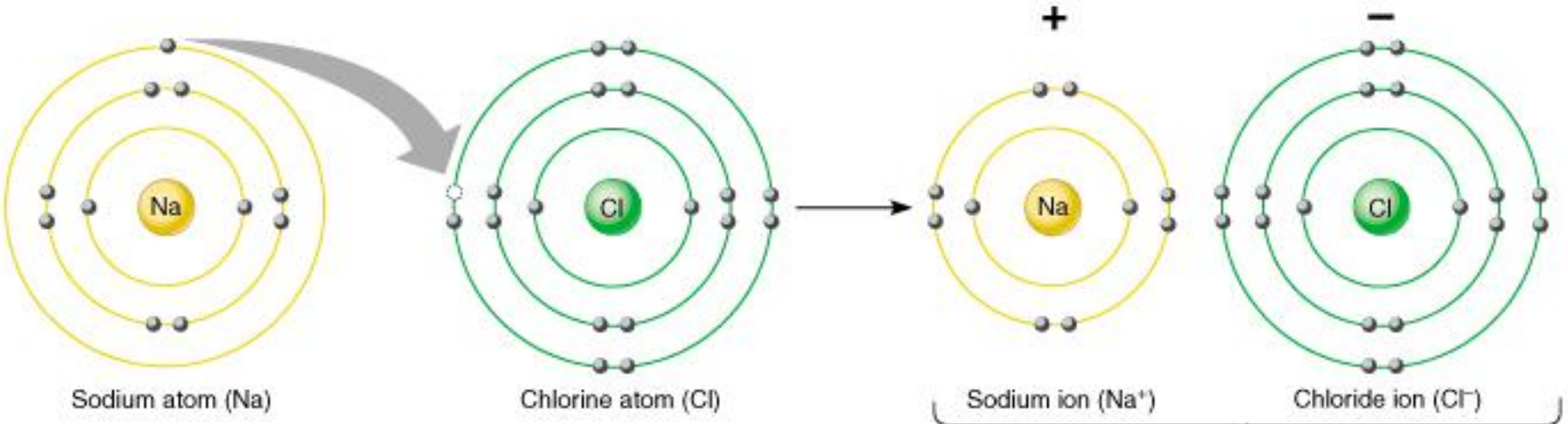
Chemical Bonds of Two or More Elements Make Chemical Units

(the various things that exist in our environment)

Types of Chemical bonds

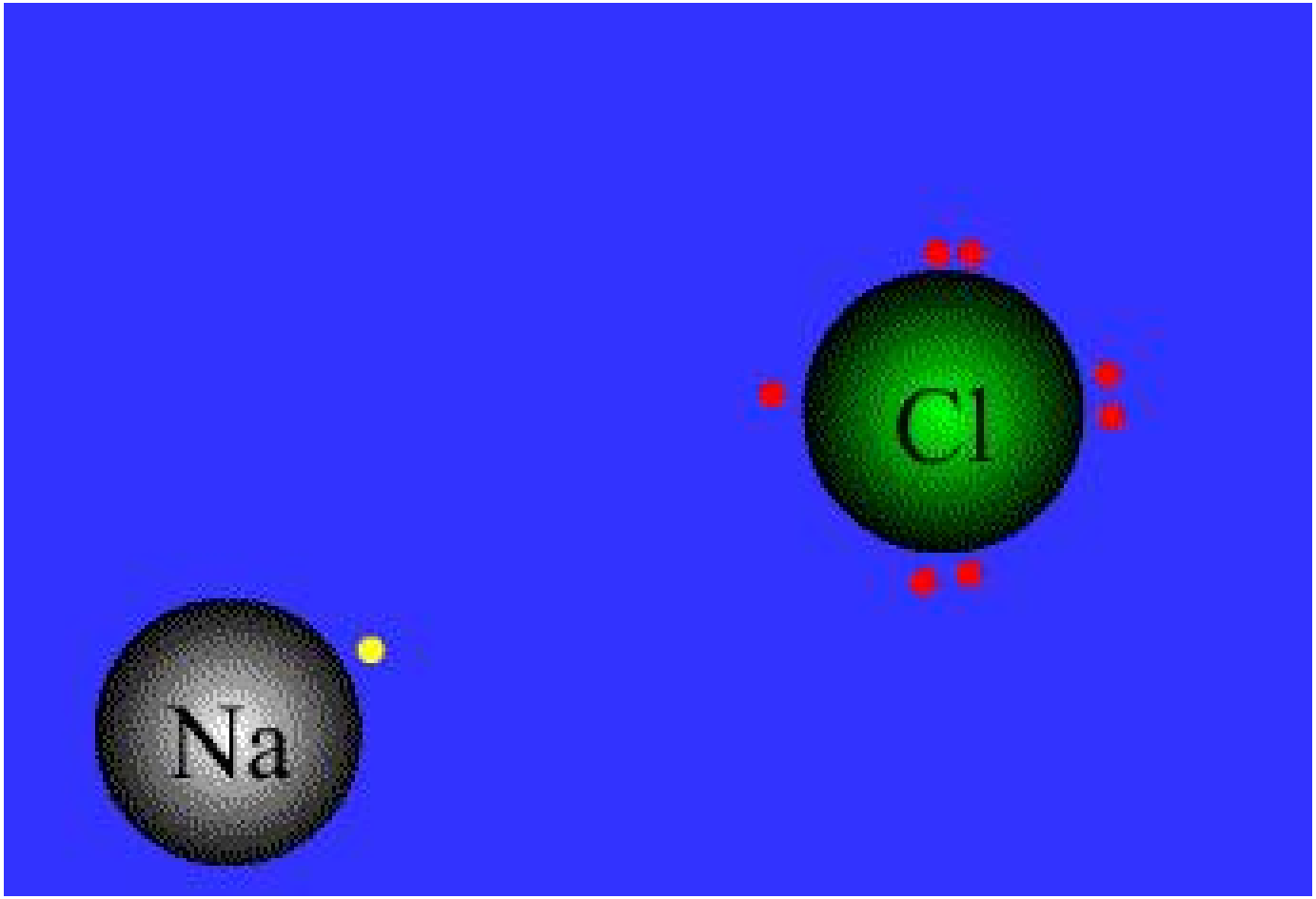
- Ionic Bonds
- Covalent
  - Non-polar
  - Polar

Ionic Bonds



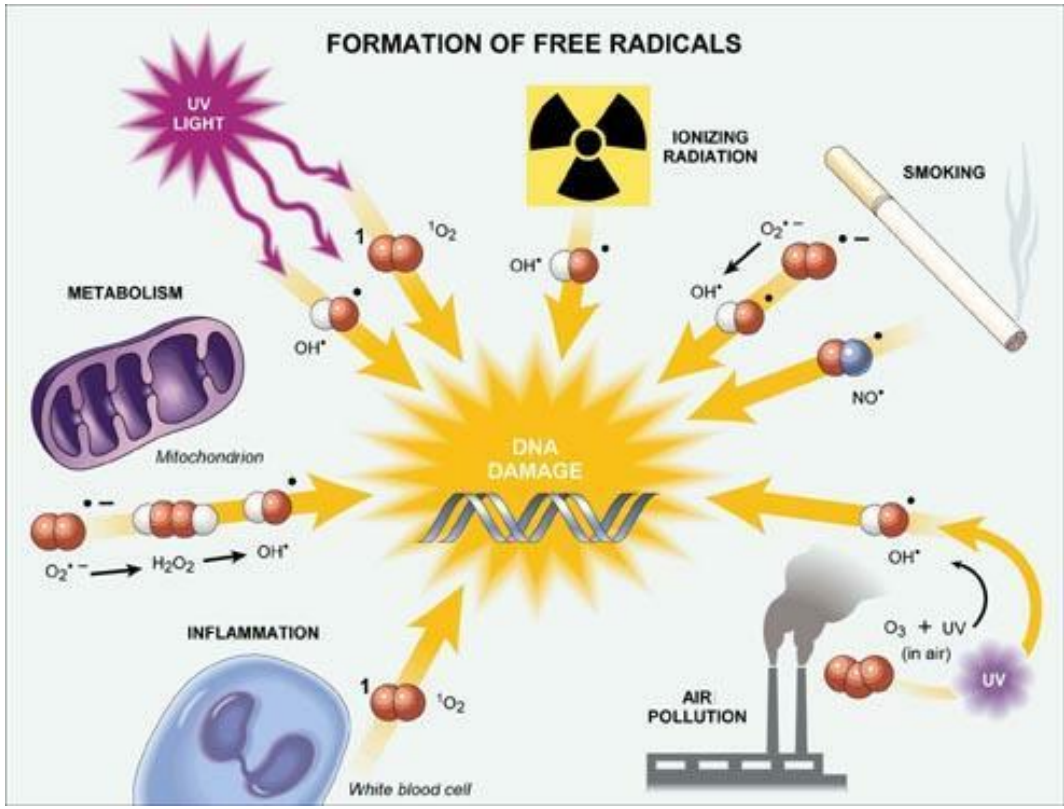
Electron donor, electron acceptor, anion, cation

Based on the electronegativity (the ability of an element to hold on or take electrons) of each element


Cl
Na

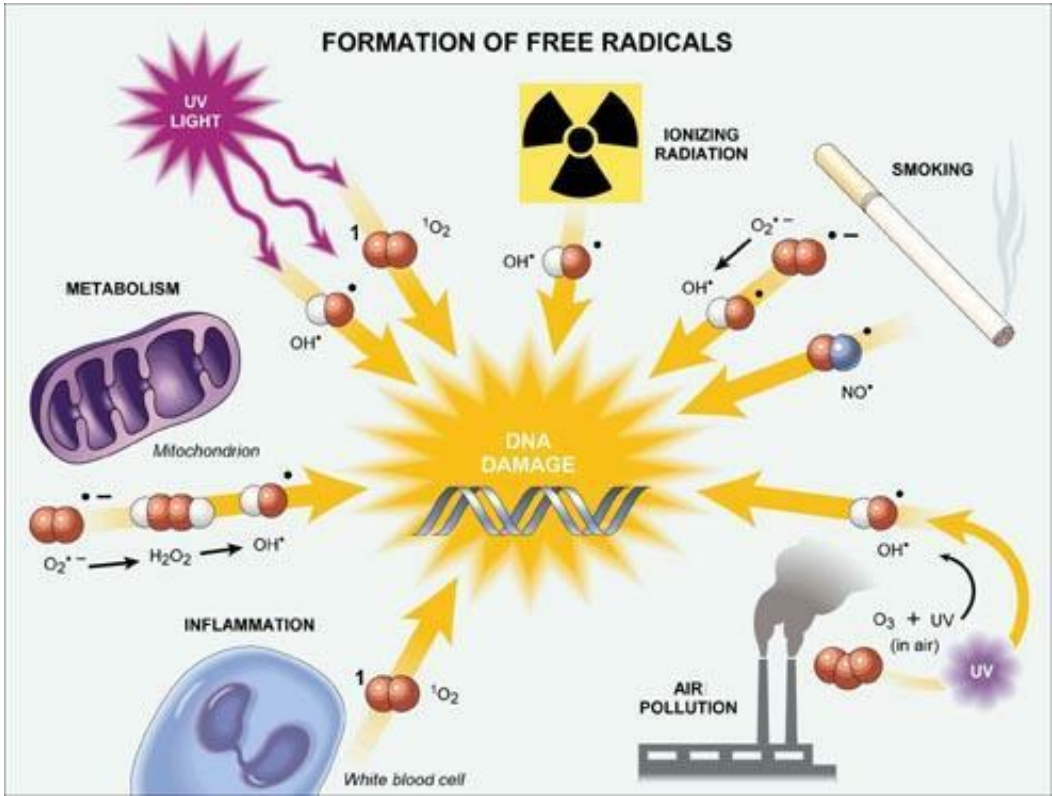
Ions

- Charged Particles
  - Electrolytes-salts that ionize in water and form solutions capable of conducting electricity
    - Many of the bodies operations are electrical
    - Electrolyte balance is very important in patient care



Free Radicals

- Free radicals- chemical particles with odd numbers of electrons
  - Produced by normal metabolism and exogenous products (carbon tetrachloride, cleaning solvent) and radiation (X-ray, UV light)
  - Damaging to the body
  - Antioxidants- neutralizes free radicals (Vit. C, E, Beta carotene)



Antioxidants

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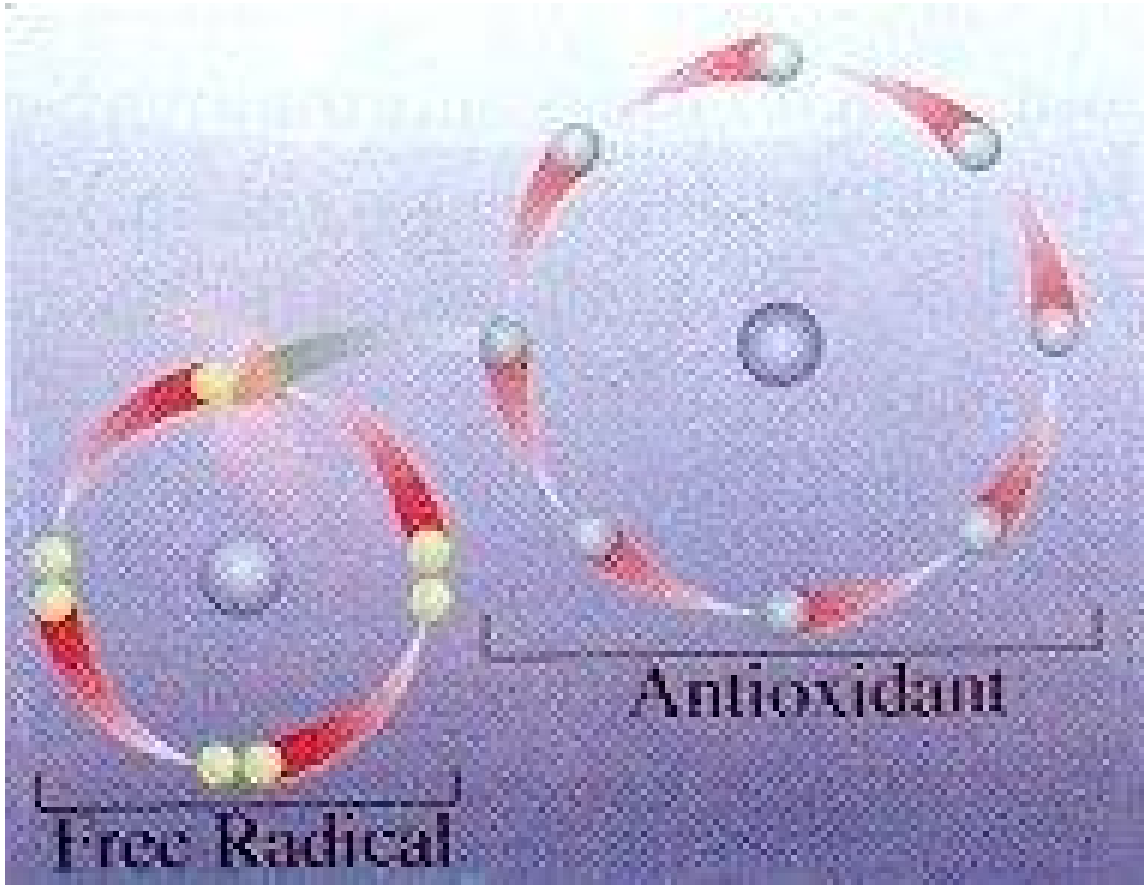
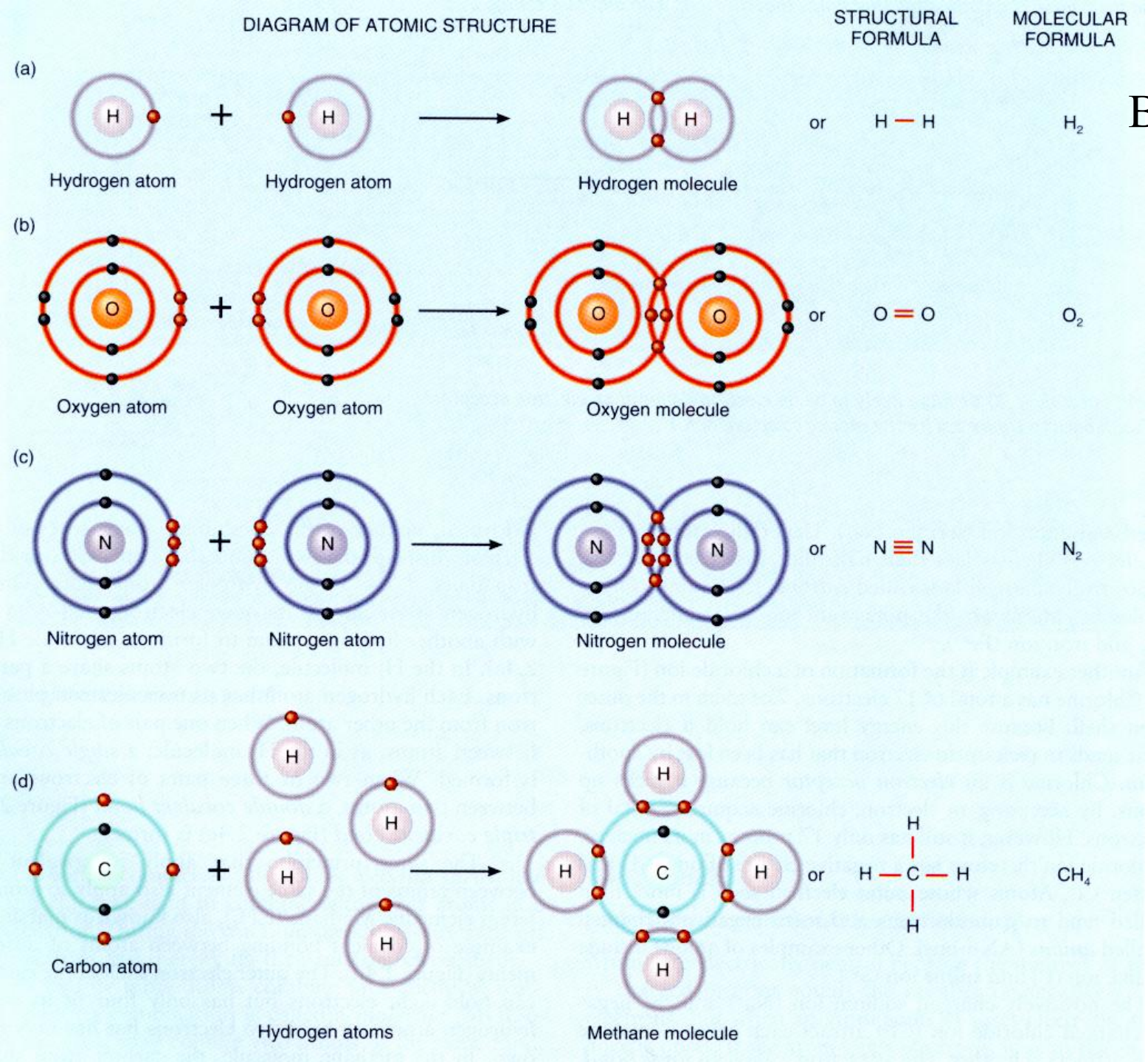


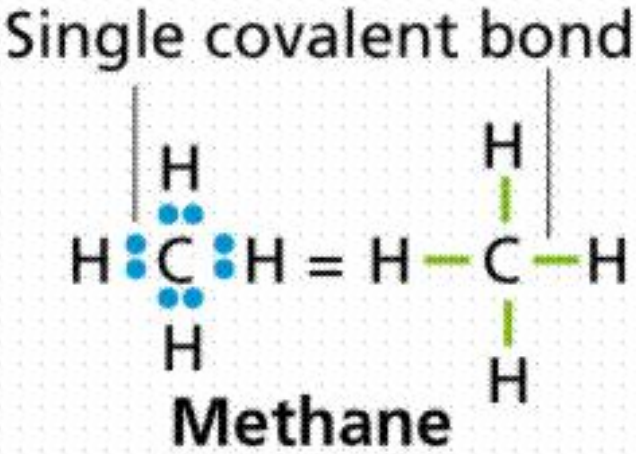


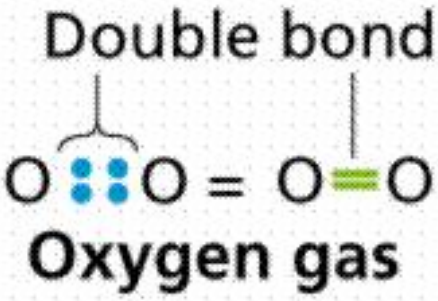
Covalent Bond- sharing of electorns

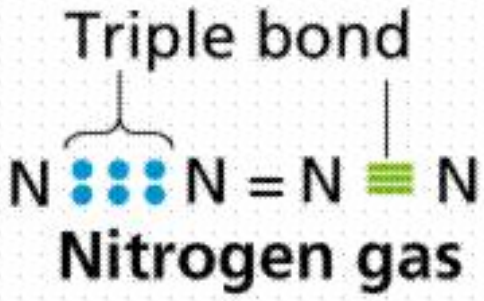
1. Nonpolar- equal sharing

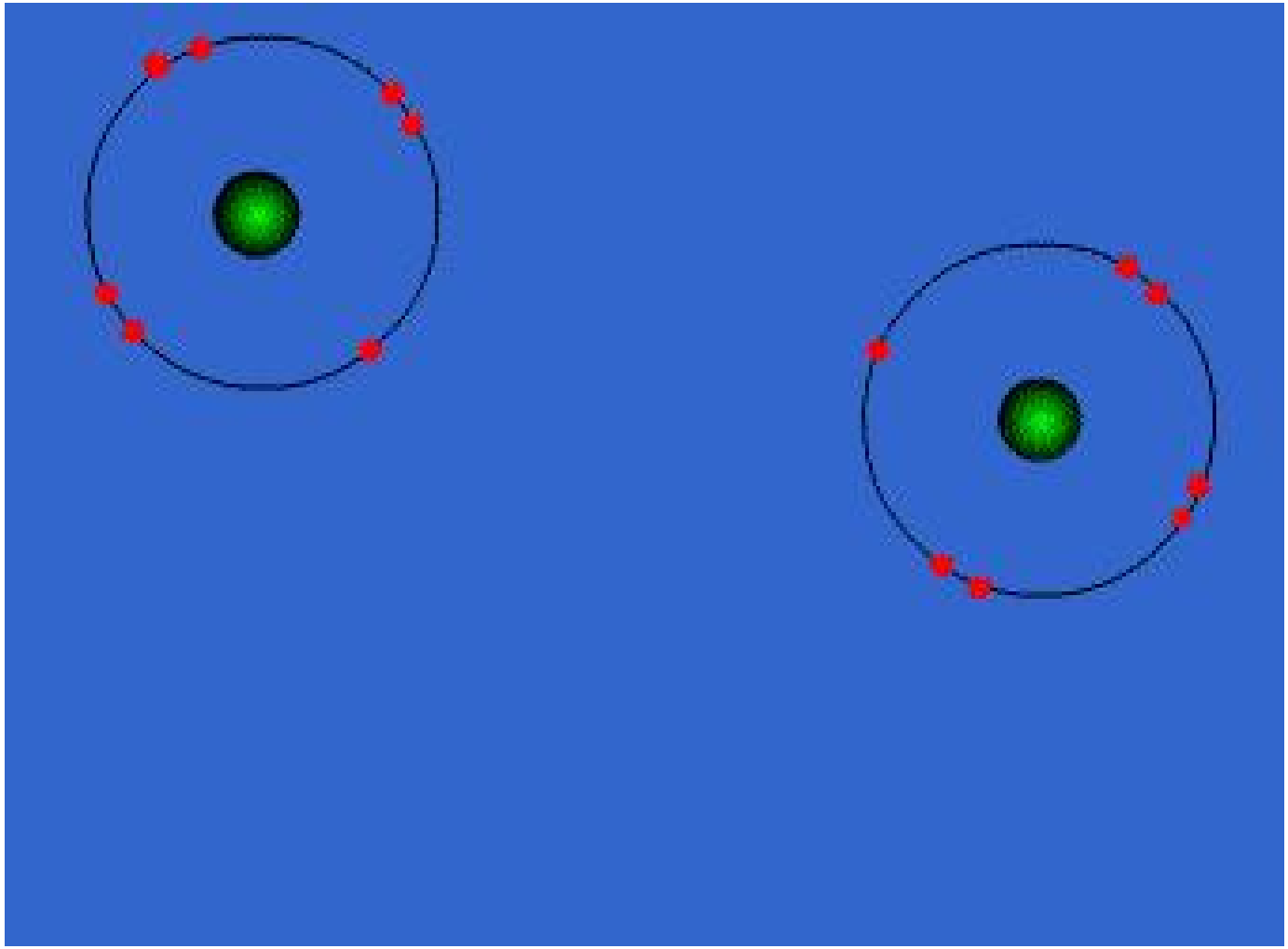
2. Polar- unequal sharing

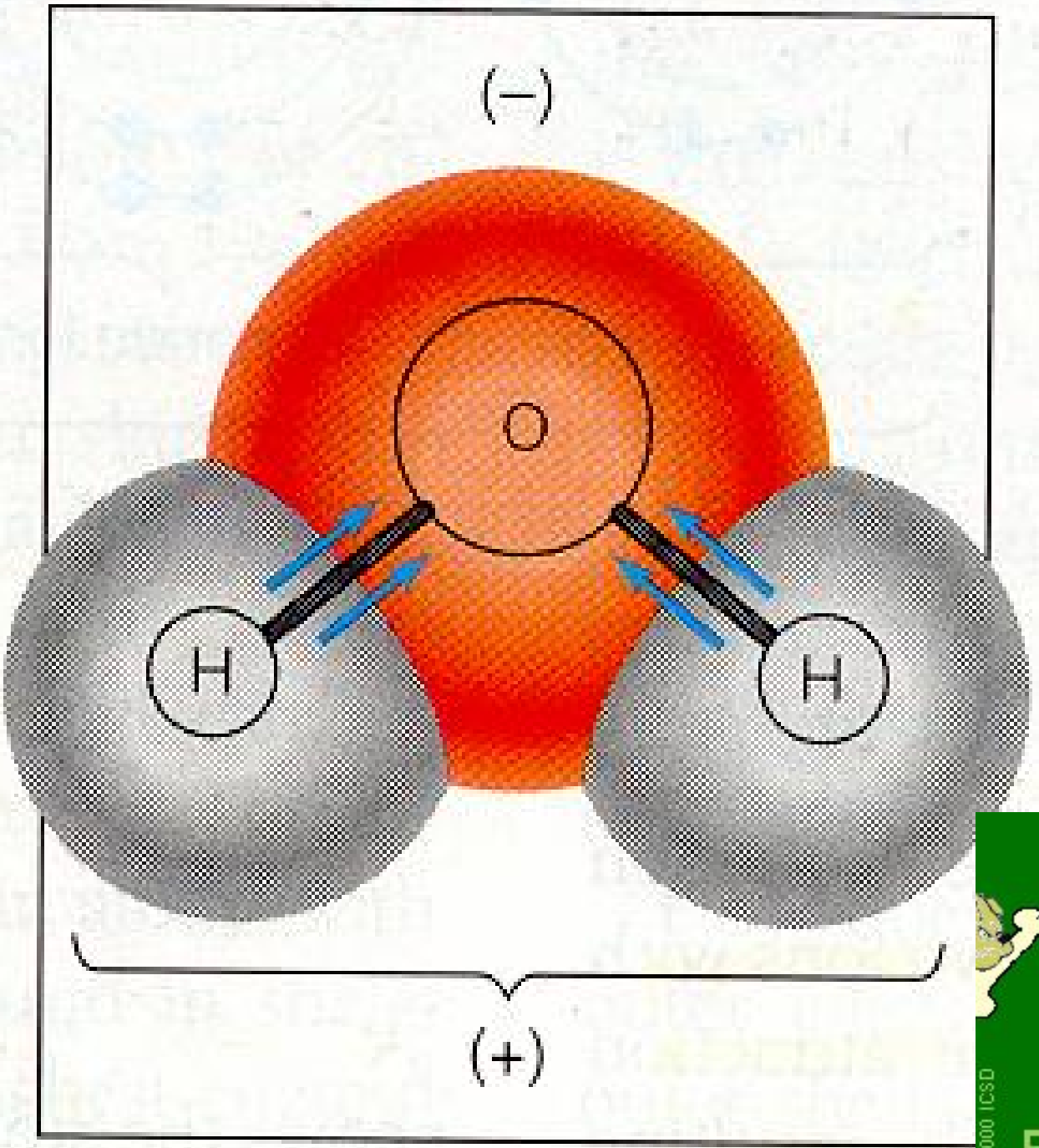
Equal Sharing





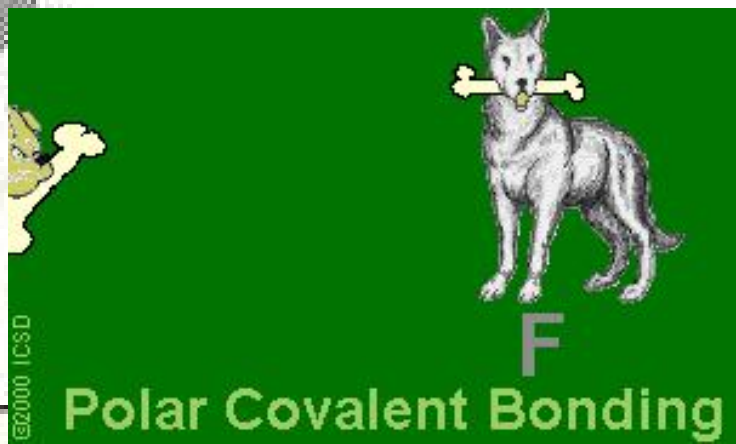


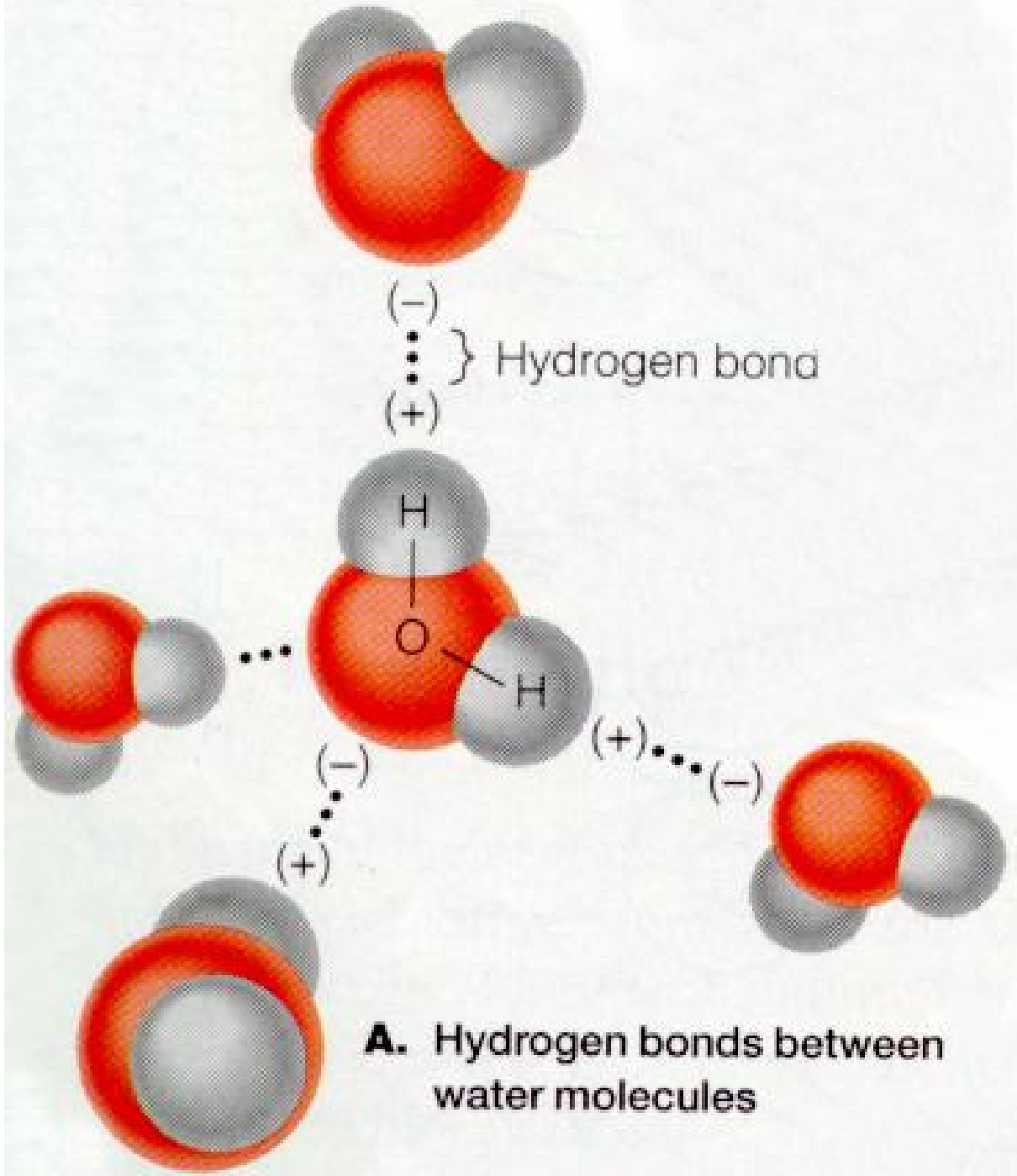




Oxygen showing unequal sharing of electrons

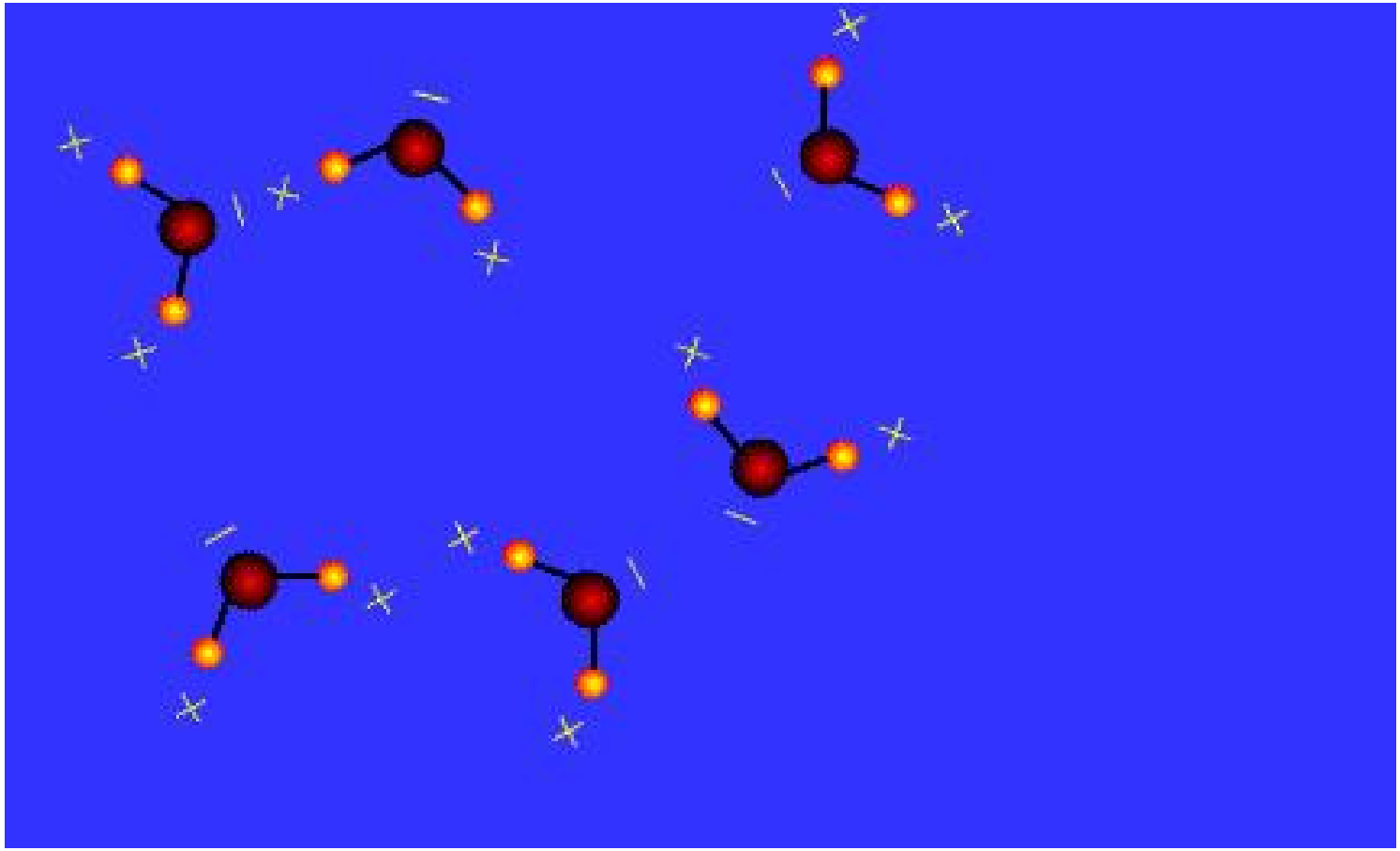
- Electronegativity
- Polar covelant bond
- Polar molecule

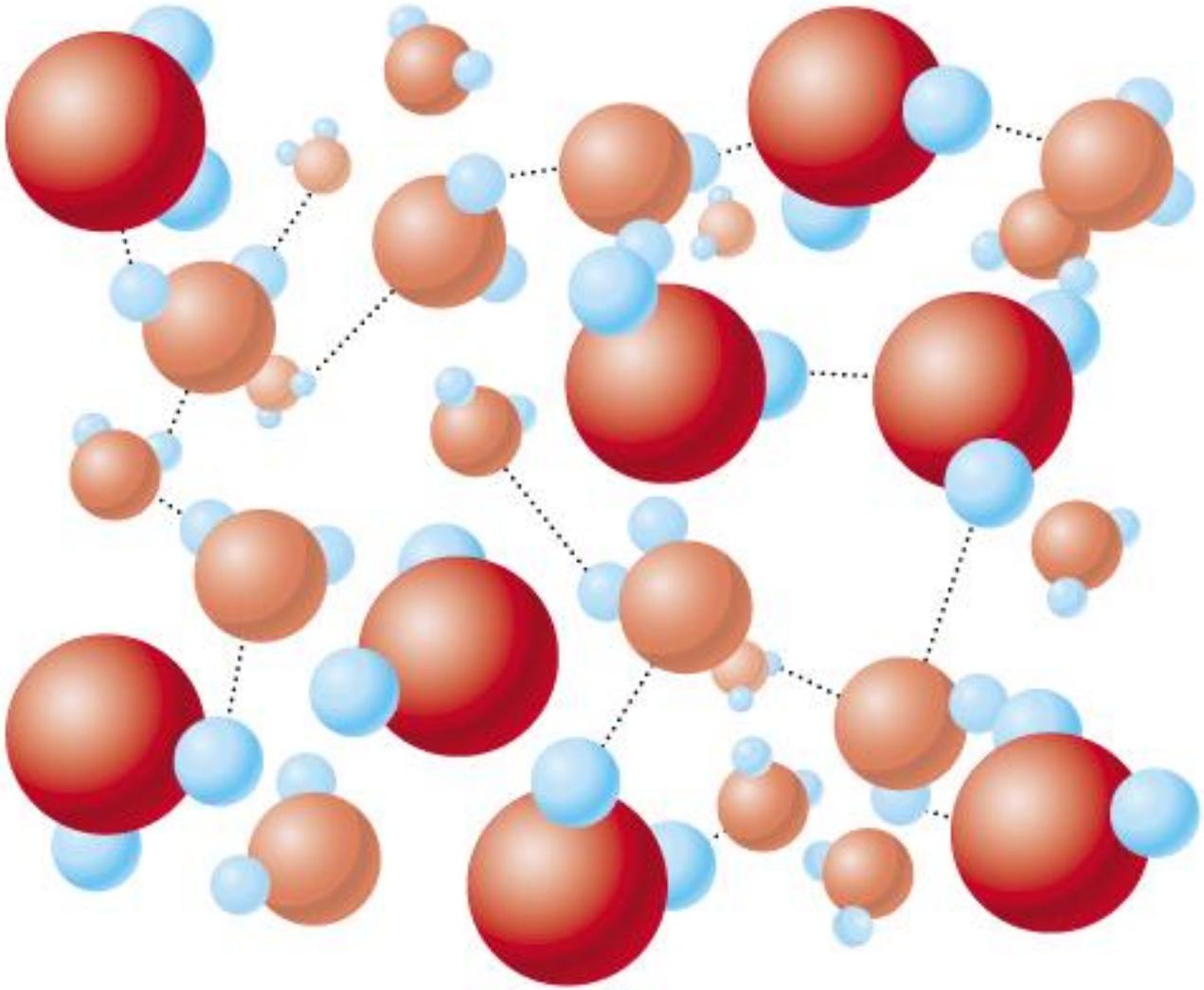




A. Hydrogen bonds between water molecules

Hydrogen Bonding





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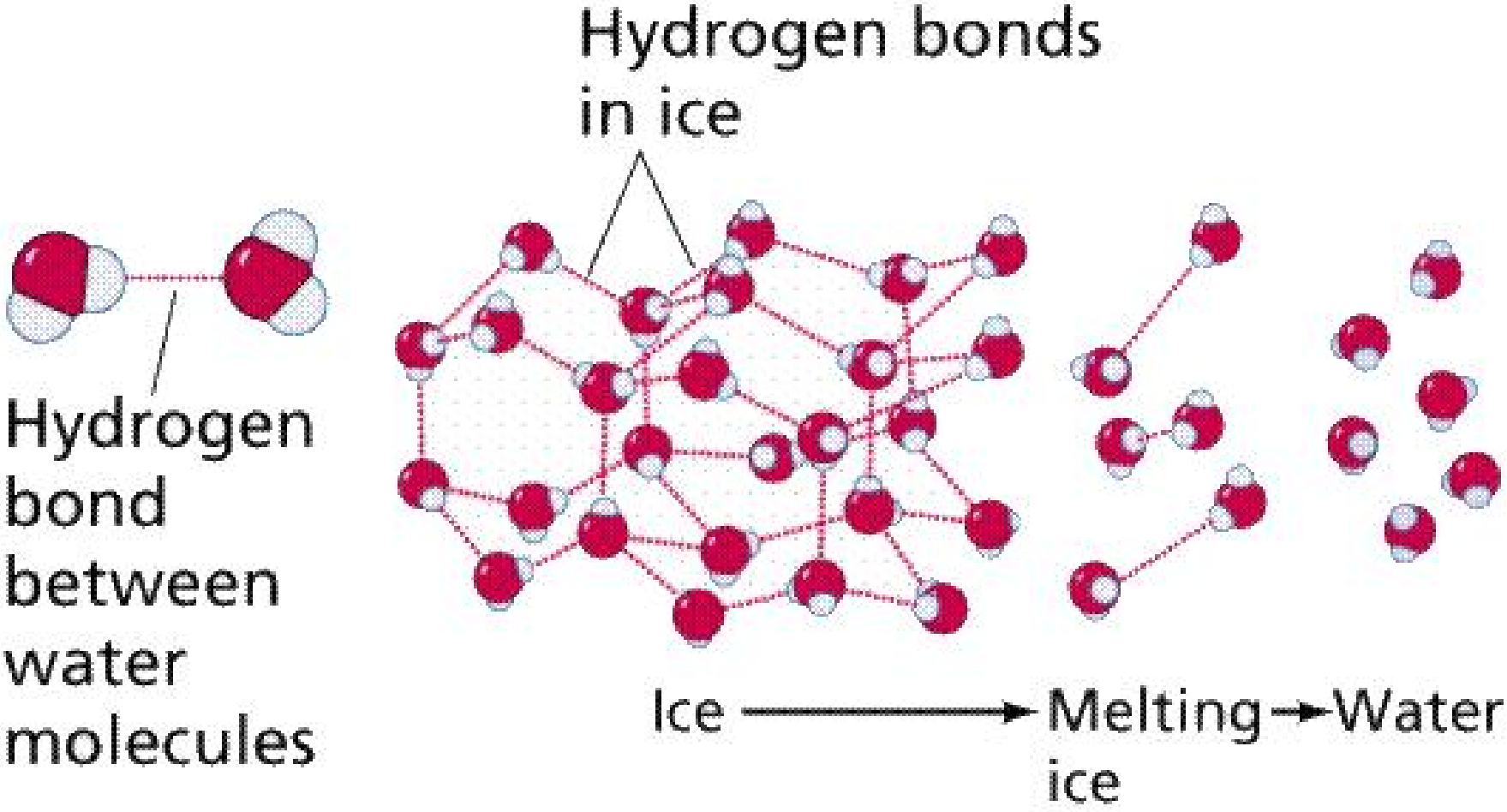

Hydrogen bonds in ice
Hydrogen bond between water molecules
Ice
Melting ice
Water

Important properties of water

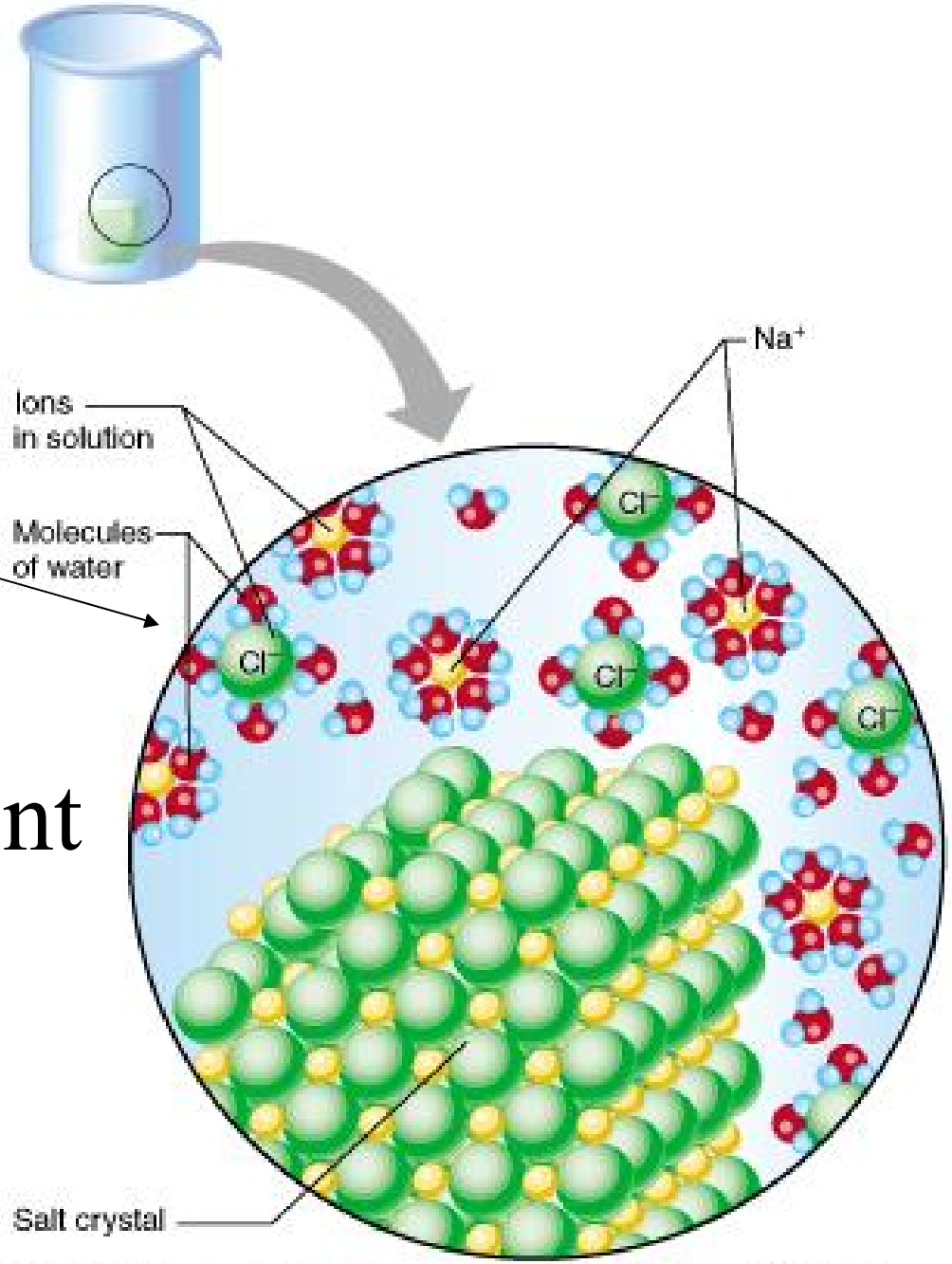
1. Excellent solvent
   - solvent- a liquid that a solid is dissolved in
   - solute- the substance that is being dissolved
2. Can participate in chemical reactions
3. Absorbs and releases heat very slowly
   - important is the body to resist temperature fluctuations
4. Requires a large amount of heat to change from a liquid to a gas
   - important in cooling the body from perspiration
5. Servers as a lubricant

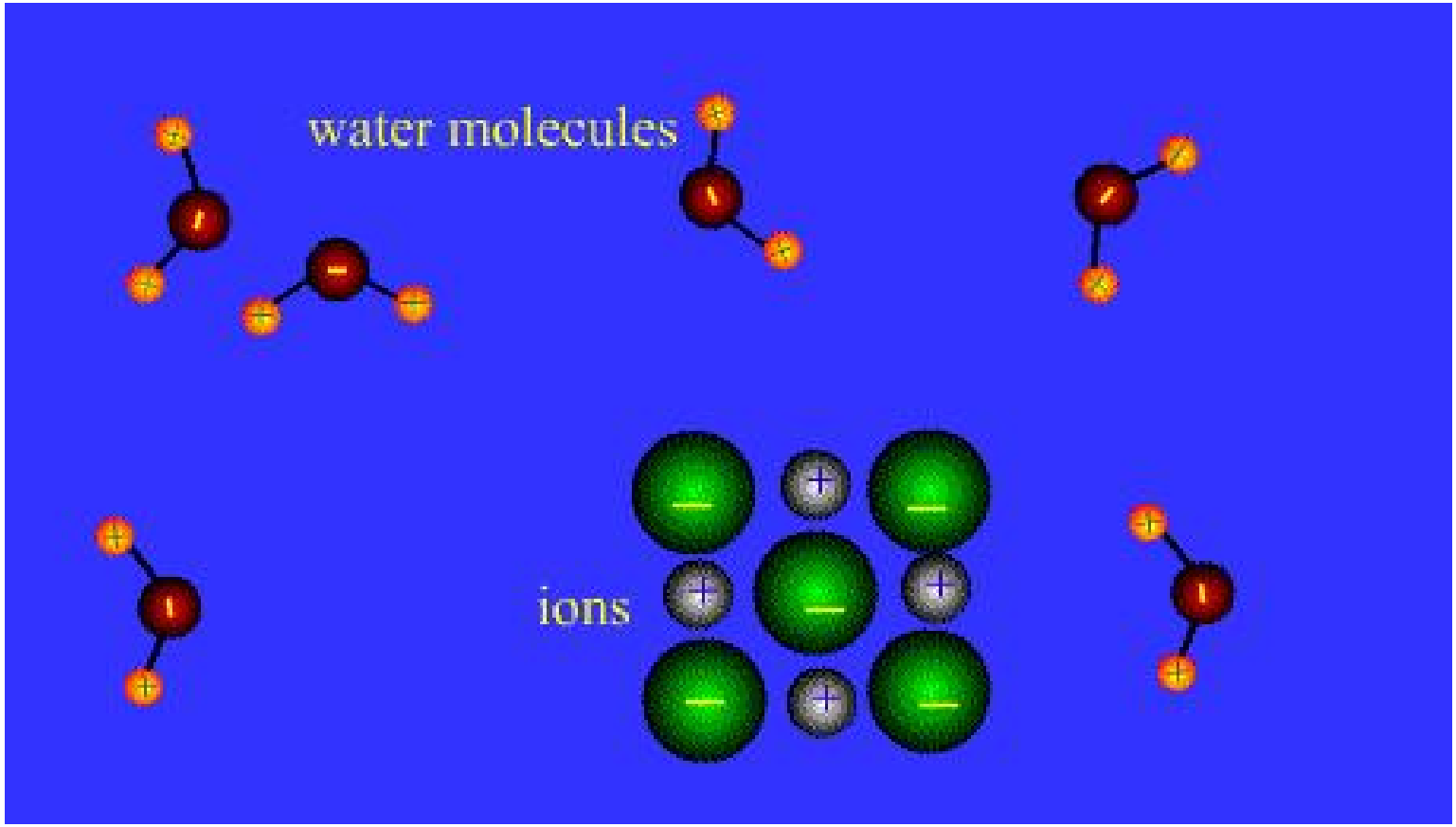
Characteristics of Water

- **Solvency**- the ability to dissolve other chemicals
  - Hydrophillic- substances that dissolve in water
  - Hydrophobic- substances that do not dissolve in water
- **Cohesion**- the tendency of molecules of the same substance to cling to each other
- **Adhesion**- the tendency of one substance to cling to another
- **Chemical reactivity-** the ability to participate in chemical reactions
- **Thermal stability-** helps to stabilize the internal temperature of the body due to its high heat capacity

Water an Excellent Solvent

Hydration sphere




water molecules
ions

Solutions, Colloids, Suspensions

Solution

- particles of matter (solute) mixed with more abundant substance, usually water (solvent).
  - Particles are under 1 nanometer (cannot be visually distinguished from each other
  - Particles do not scatter light so solution is transparent
  - The solute particles will pass through most selectively permeable membranes
  - Solute does not separate from solvent when the solution is allowed to stand

Solution

Solutions, **Colloids**, Suspensions

Colloid- example is plasma proteins (albumin)

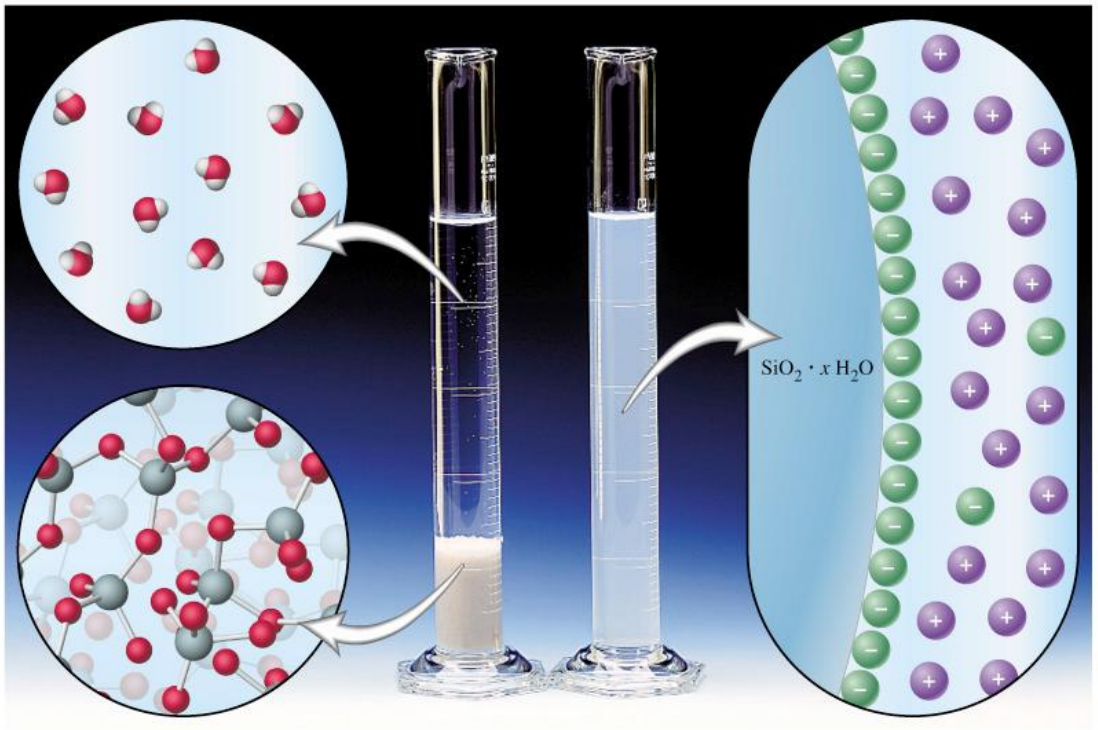
- Particles range from 1-100 nm in size
- Particles are large enough to scatter light, so colloids are usually cloudy
- Particles are to large to pass through most selectively permeable membranes
- Particles remain mixed with solvent when the mixture is allowed to stain

Colloid

Solutions, Colloids, **Suspensions**

Suspension- example, blood cells in plasma

- Particles exceed 100 nm
- Suspension is cloudy or opaque
- Particles are too large to penetrate selectively permeable membrane
- Particles are too heavy to remain suspended when the mixture is allowed to stand



Emulsion

- Suspension of one liquid in another, such as oil and vinegar salad dressing

Mixture

Consists of substances that are physically blended but not chemically combined

Concentration

- How much solute is present in a given volume of solution
- Concentration is expressed in different ways
  - Weight per volume
  - Percentages
  - Molarity
  - Electrolyte concentration

Weight Per Volume

- The weight of solute in a given volume of solution
- Ex:

8.5 g of NaCl per liter of solution (8.5g/L)

Percentages

5g of dextrose and add enough water ot make 100ml of solution = concentration of 5% weight per volume

Ex: D5W= 5% w/v dextrose in distilled water

Molarity

- Mole- Avogadro's number of particles (atoms, molecules, etc.)

  6.023×10^{23} particles

  Ex: mole of glucose weighs 180 grams

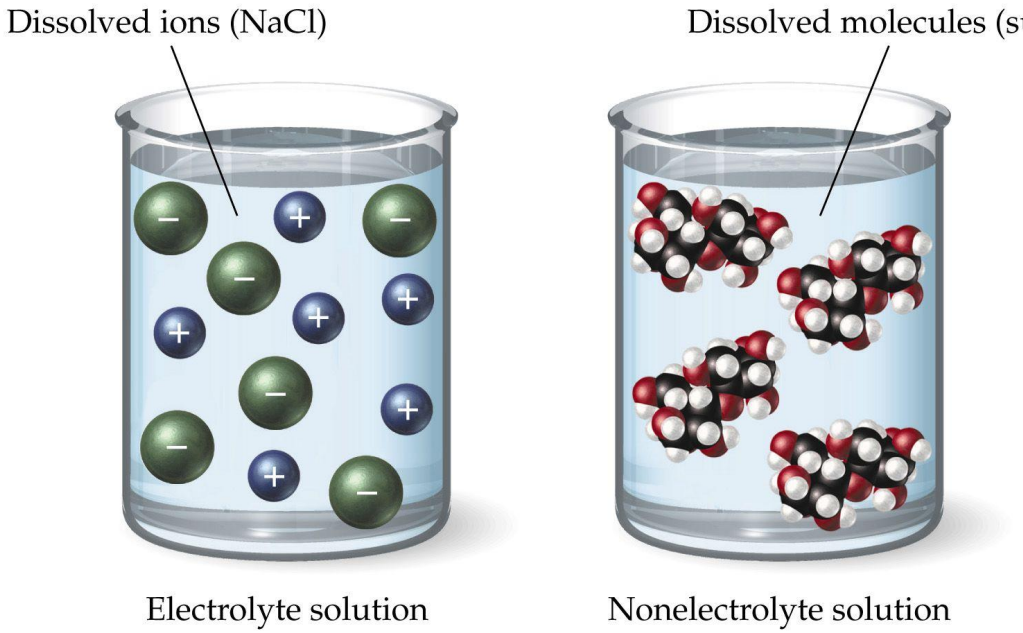
  mole of sucrose weighs 342 grams

- Molarity- the number of moles of solute per liter of solution

  A one molar (1.0 M) solution of glucose contains 180 g/L and a one molar (1.0 M) solution of sucrose contains 342 g/L

Electrolytes

- A material that dissolves in water to give a solution that conducts an electrical current
- major electrolytes of the body are as follows:
  - sodium (Na+)
  - potassium (K+)
  - chloride (Cl-)
  - calcium (Ca2+)
  - magnesium (Mg2+)
  - bicarbonate (HCO3-)
  - phosphate (PO42-)
  - sulfate (SO42-)

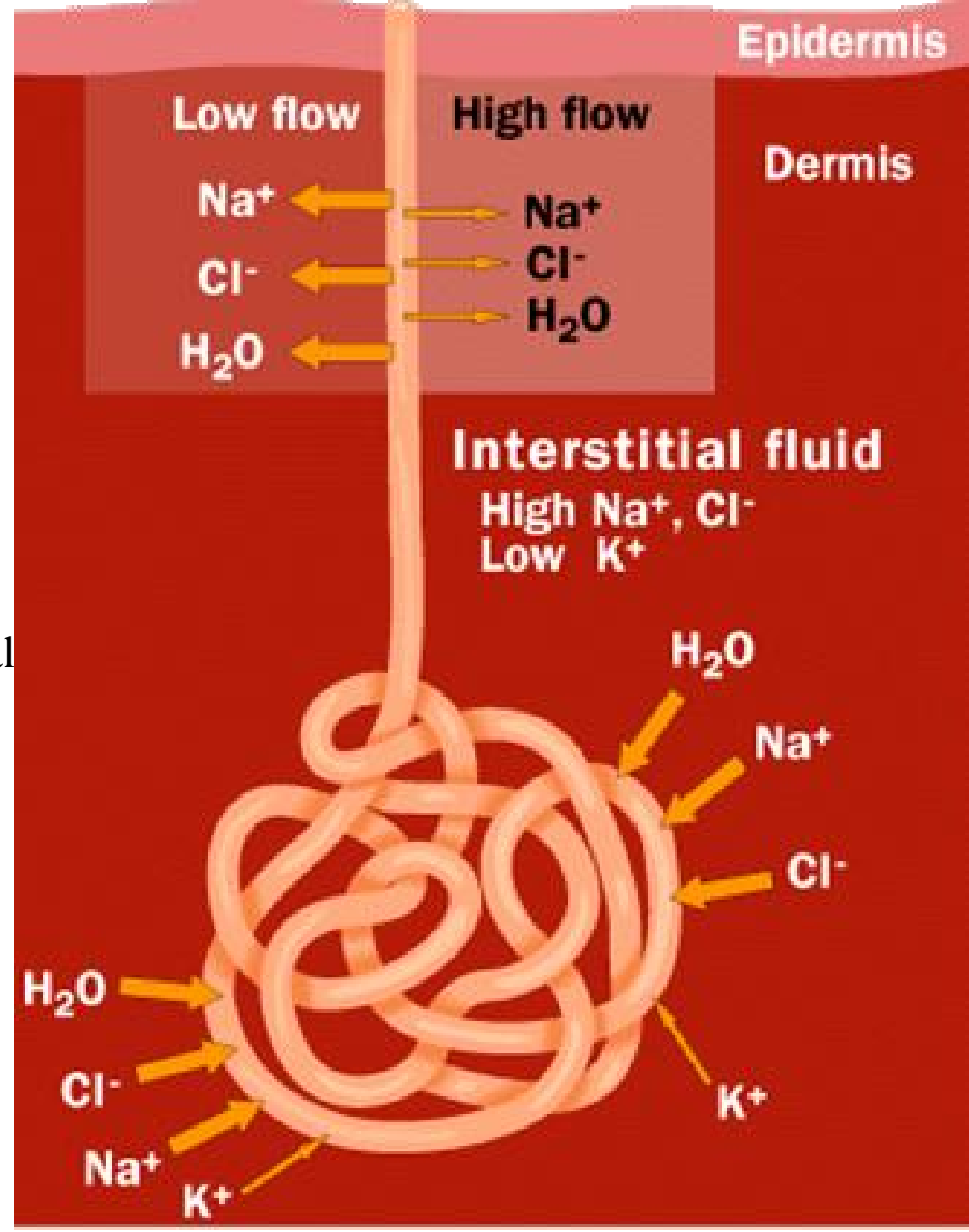


Electrolytes

- Important for their chemical, physical (osmotic), and electrical effects on the body
- Common disruption due to
  - sweating
  - Diarrhea
  - Vomiting
  - Hormone imbalance
  - Kidney disorders

Electrolytes in Sweating

- Heat control
- Two types
  - **Eccrine** - the most numerous type that are found all over the body, particularly on the palms of the hands, soles of the feet and forehead
  - **Apocrine** - mostly confined to the armpits (**axilla**) and the anal-genital area. They typically end in hair follicles rather than pores.
- Compared to apocrine glands, eccrine glands:
  - are smaller
  - are active from birth (Apocrine glands become active only at puberty)
  - produce a sweat that is free of proteins and fatty acids
- Loss of Na^+, Cl^-, H_2O



Movement of ions and water in making sweat

Electrolytes in Sweating

- the sweat from apocrine glands also contains proteins and fatty acids, which make it thicker and give it a milkier or yellowish color.
  - This is why underarm stains in clothing appear yellowish.
  - Sweat itself has no odor, but when bacteria on the skin and hair metabolize the proteins and fatty acids, they produce an unpleasant odor.
  - This is why deodorants and anti-perspirants are applied to the underarms instead of the whole body.
- The maximum volume of sweat that a person who is not adapted to a hot climate can produce is about **one liter per hour.**
- Amazingly, if you move to a hot climate such as the American desert southwest or the tropics, your ability to produce sweat will increase to about **two to three liters per hour** within about six weeks! This appears to be the maximum amount that you can produce.

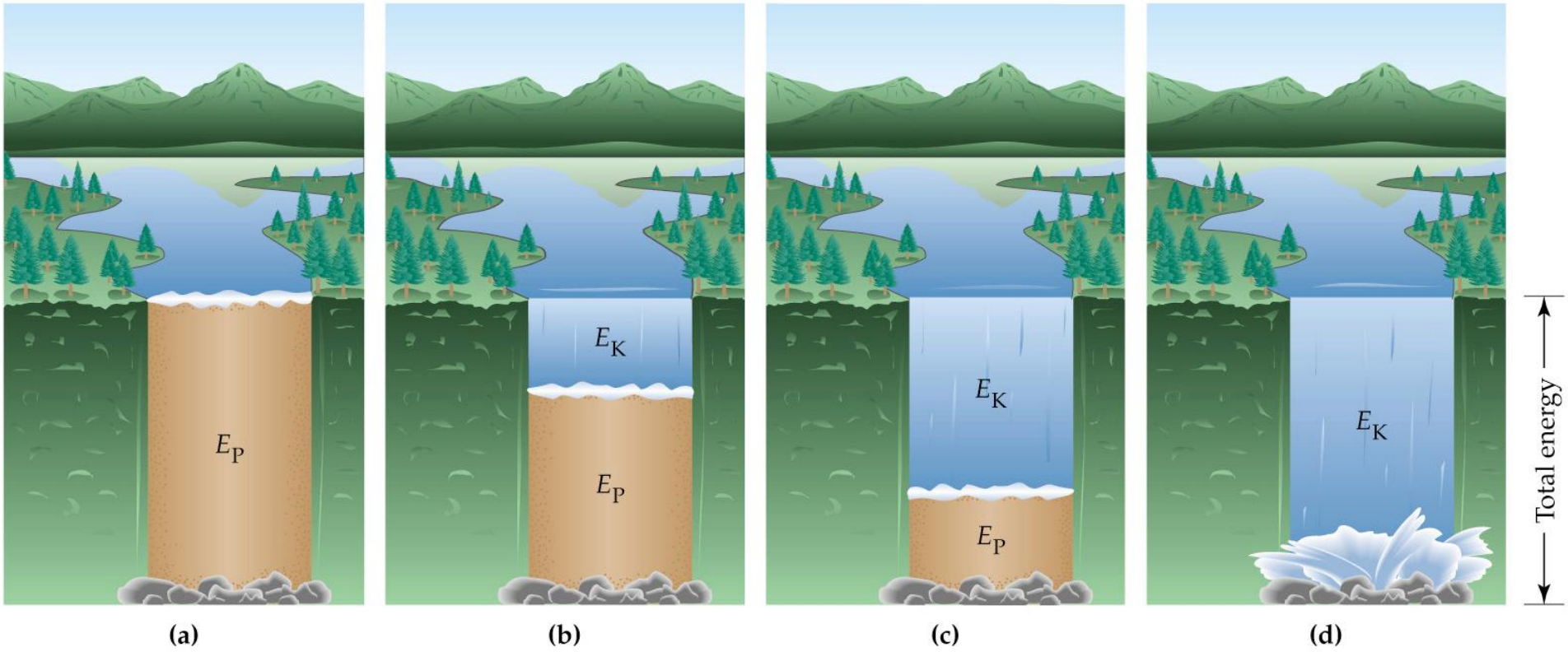
Electrolyte Measurement

- Effects depend on
  - Concentration
  - Charge
- Equivalent (Eq)- the amount of electrolyte that would neutralize 1 mole of hydrogen inos (H^+) or hydroxide ions (OH^-)

Energy and Work

- Energy- is the capacity to do work
  - Potential energy- energy contained in an object because of its position or internal state but is not being used to do work
  - Kinetic energy- energy of motion, energy that is doing work
- Work- means to move something whether it's a muscle or a molecule, breaking chemical bonds, building molecules, etc.

Potential and Kinetic Energy



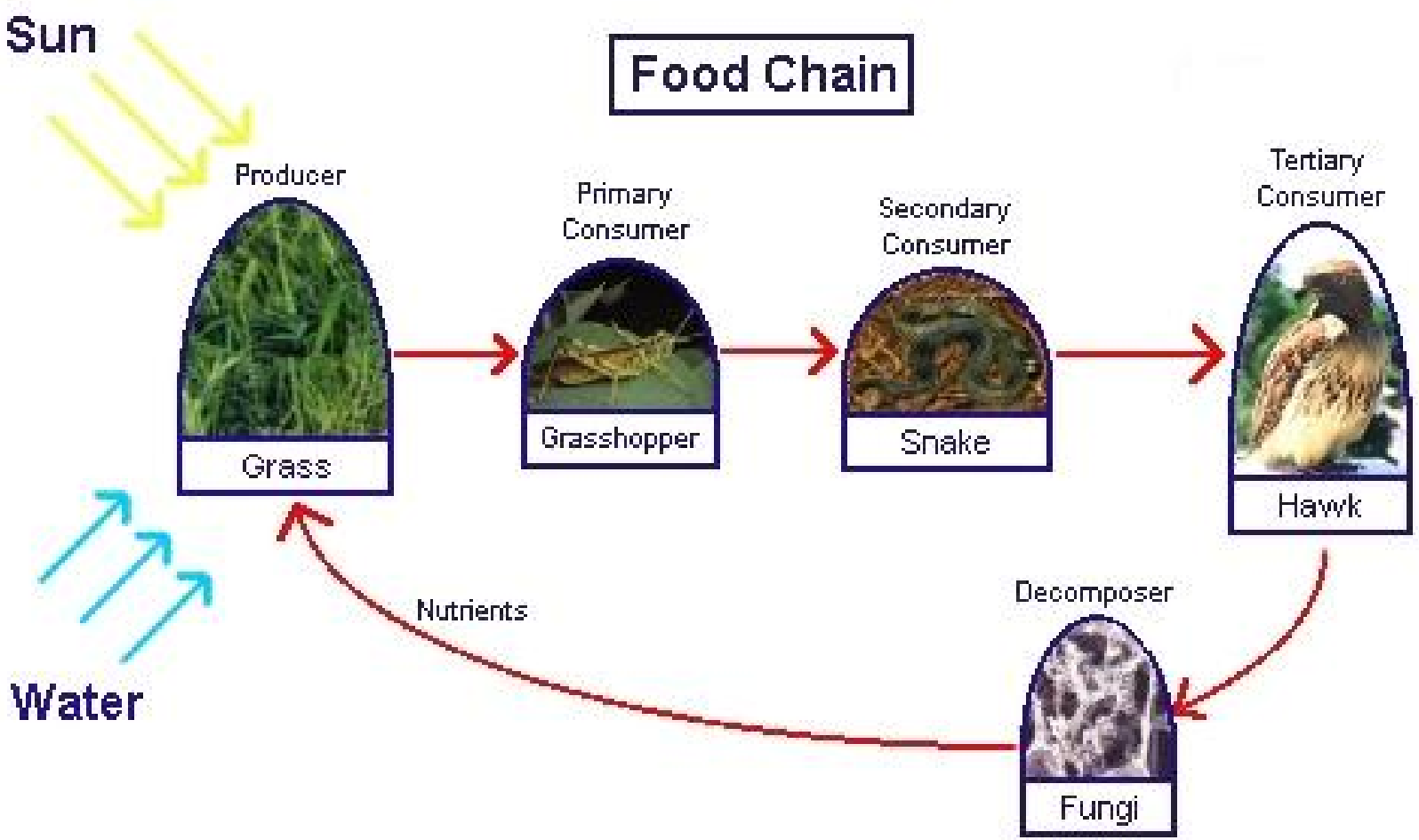
Energy and Work

- **Chemical energy** is potential energy stored in the bonds of molecules.
  - Chemical reactions release this energy and makes it available to do physiological work.
  - Heat is the kinetic energy of molecular motion
    - Temperature- the measure of the rate molecular motion
- **Electromagnetic energy-** the kinetic energy of moving packets of radiation called **photons** (Ex: light)
- **Electrical energy-** has both

  potential
  - in a battery when charged particles accumulated at a point
  - in a cell when charged particles accumulate across a cell membrane

  kinetic
  - when electrons move through wires or
  - sodium moving across a cell membrane

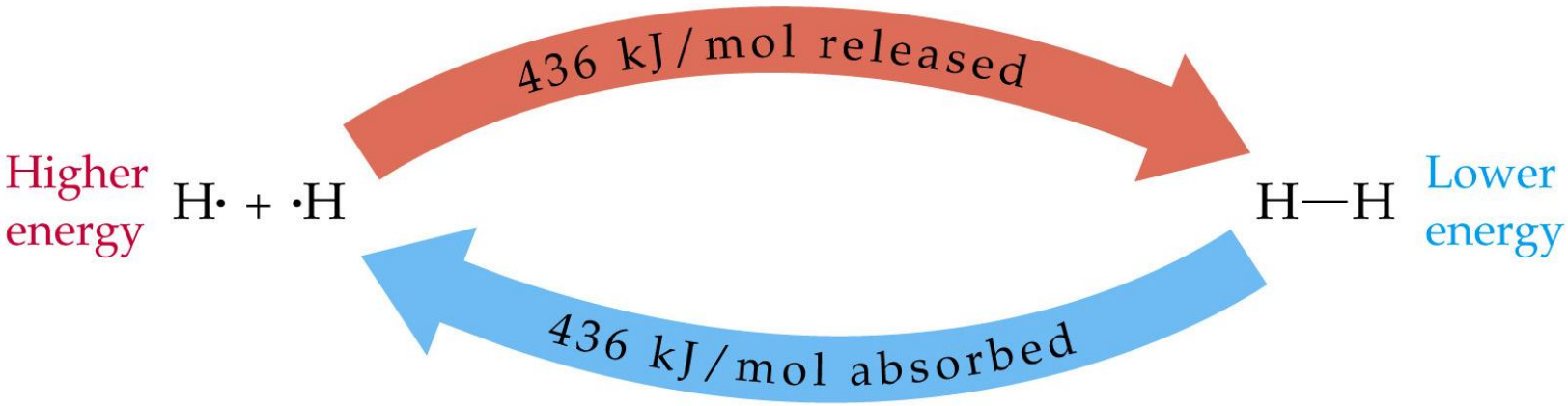
All Living Systems Need Energy For Physiological Work (Chemical Reaction)



Chemical Reactions

- A chemical change whereby compounds are formed or decomposed.
  - Accomplished by the making or breaking of bonds
- **reactants** disappear as chemical change occurs.
- **products** appear as chemical change occurs.
- **catalysts** speed up the reaction, but aren't produced or consumed.

There is Energy in Chemical Bonds



- Energy is released when bonds are broken.
- Energy is needed in order for bonds to form.

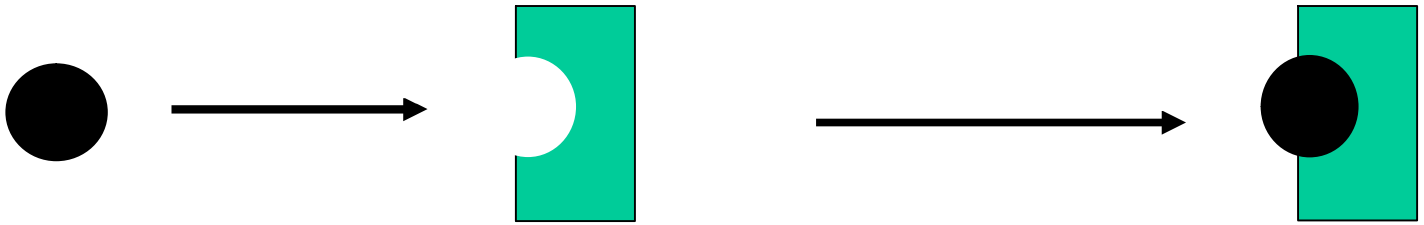
The Nature of the Chemical Reaction

Chemicals must

- collide and
- collide at the correct orientation

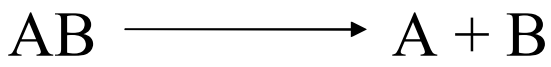
Energy Barrier or energy of activation

A + B → C

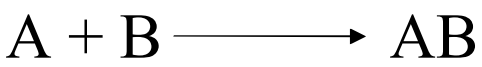


Types of Chemical Reactions

- Decomposition

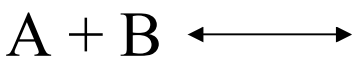


- Synthesis

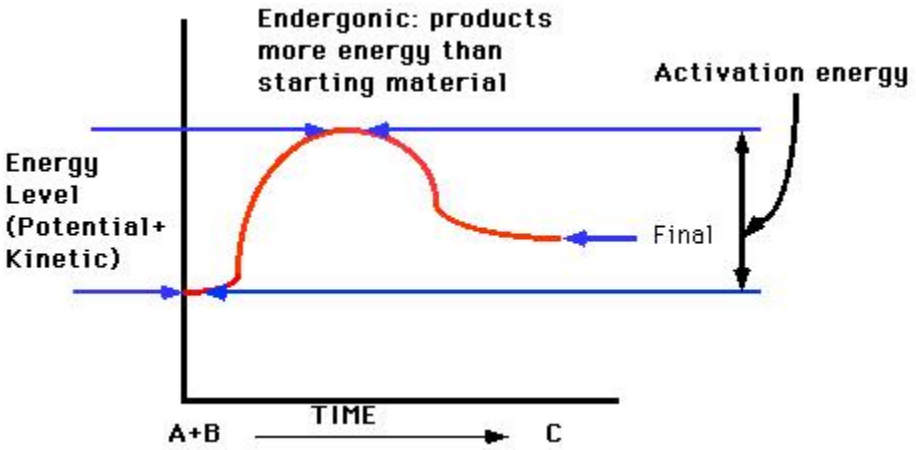


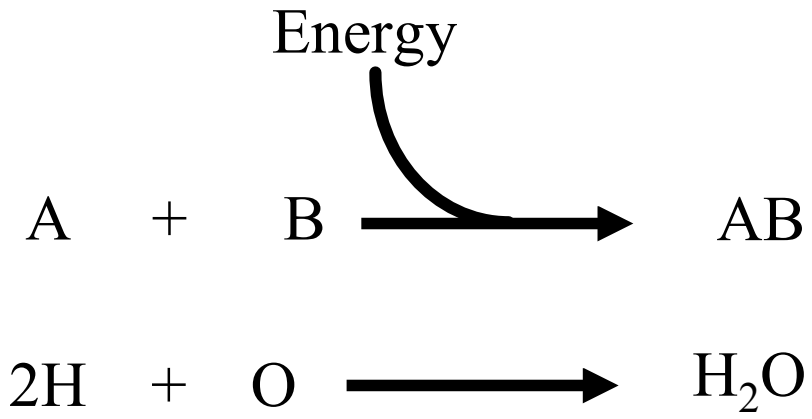
- Exchange reactions

- Some reactions are reversible

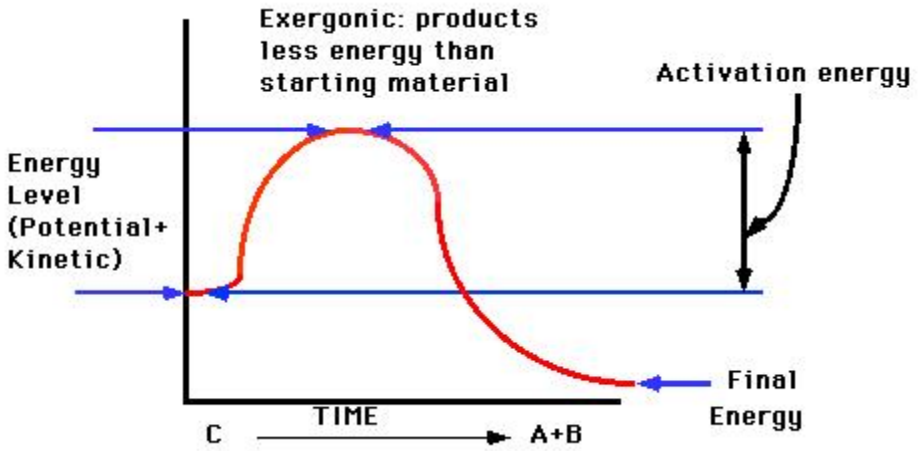


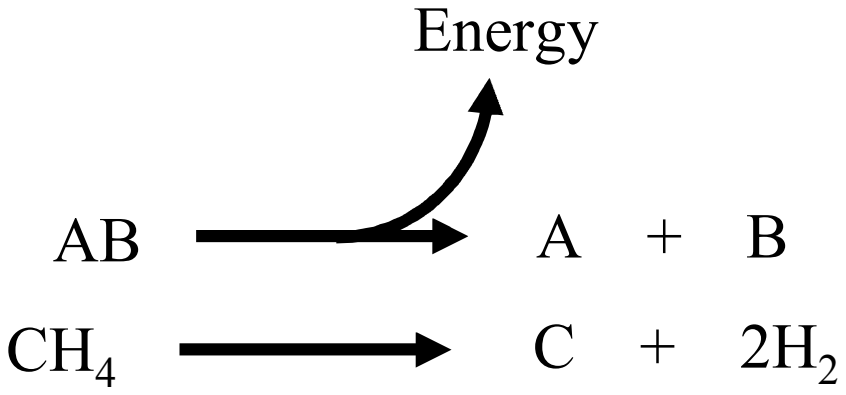
Endergonic Chemical Reactions (Synthesis or Combination)

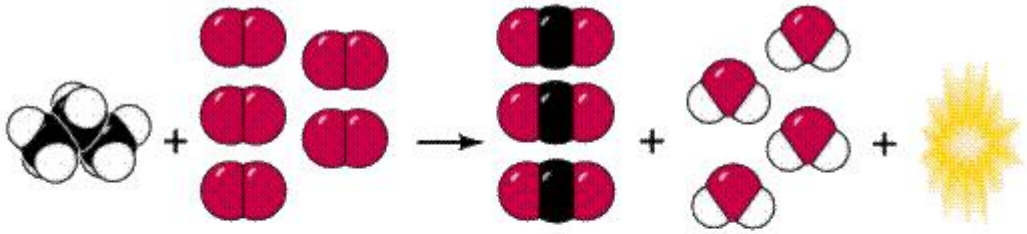




Exergonic Reation (Disassociation)





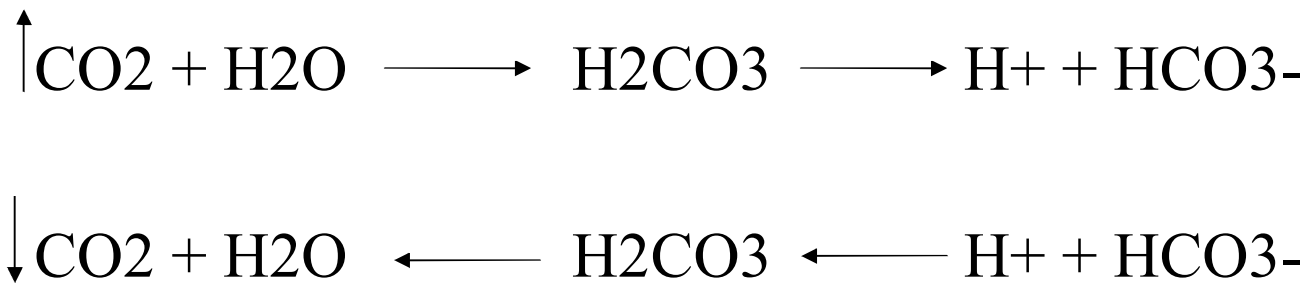


C_3H_8 + 5 O_2 → 3 CO_2 + 4 H_2O + Heat and light

Propane Oxygen gas → Carbon dioxide Water

Law of Mass Action

- Pertains to reversible reactions when the reaction proceed from the side with the greater quantity of reactants to the side with the lesser quantity

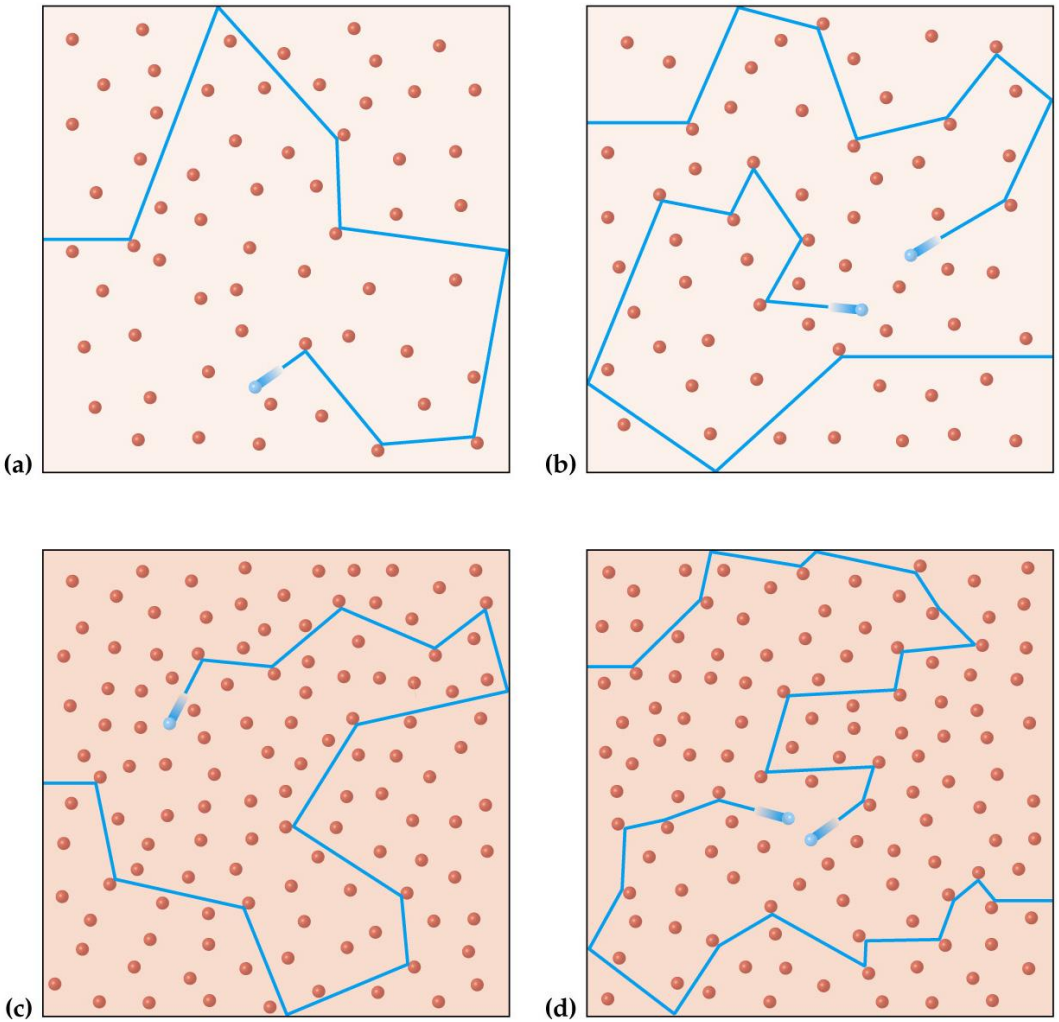


Reaction Rate

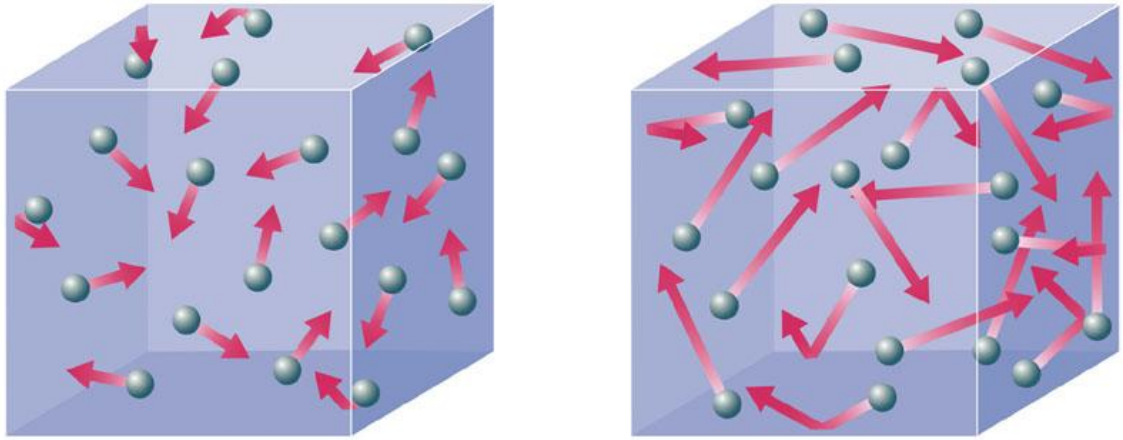
- The amount of product formed per unit time depends on
- **Concentration-** the greater the concentration of reactants the greater the rate of reaction
- **Temperature-** the higher the temperature the greater the rate of reaction
- **Catalysts-** increases the speed of the reaction.

Concentration and Reaction Rate

- The greater the concentration of reactants the greater the opportunity for collision



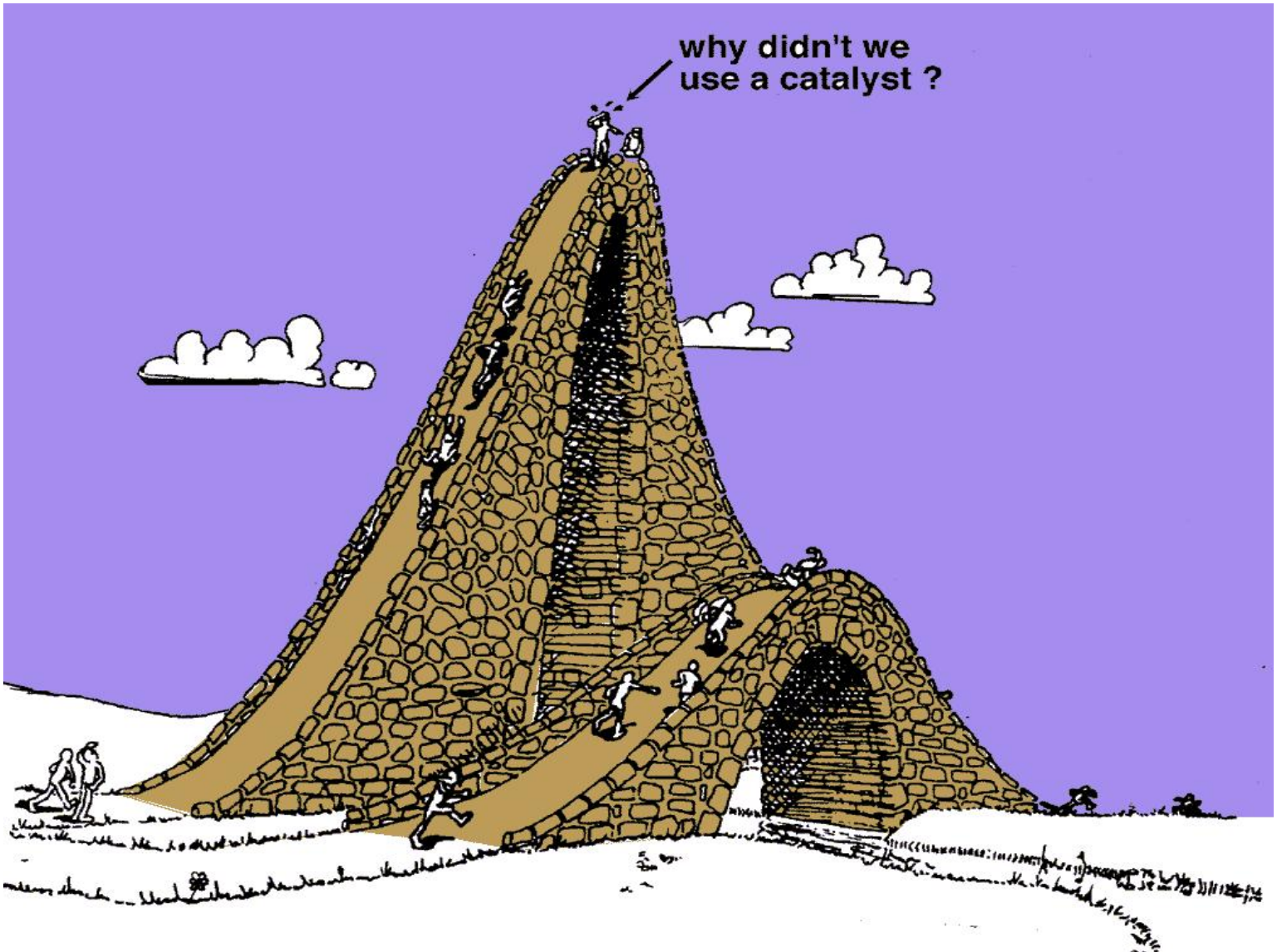
Temperature and Reaction Rate



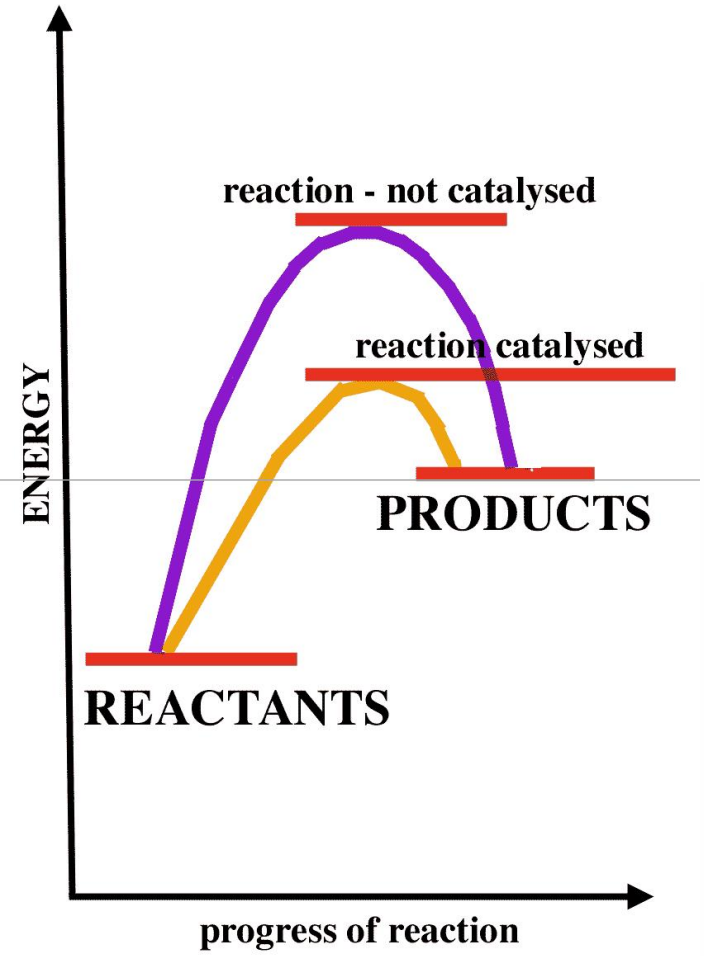
Longer arrows mean higher average speed.

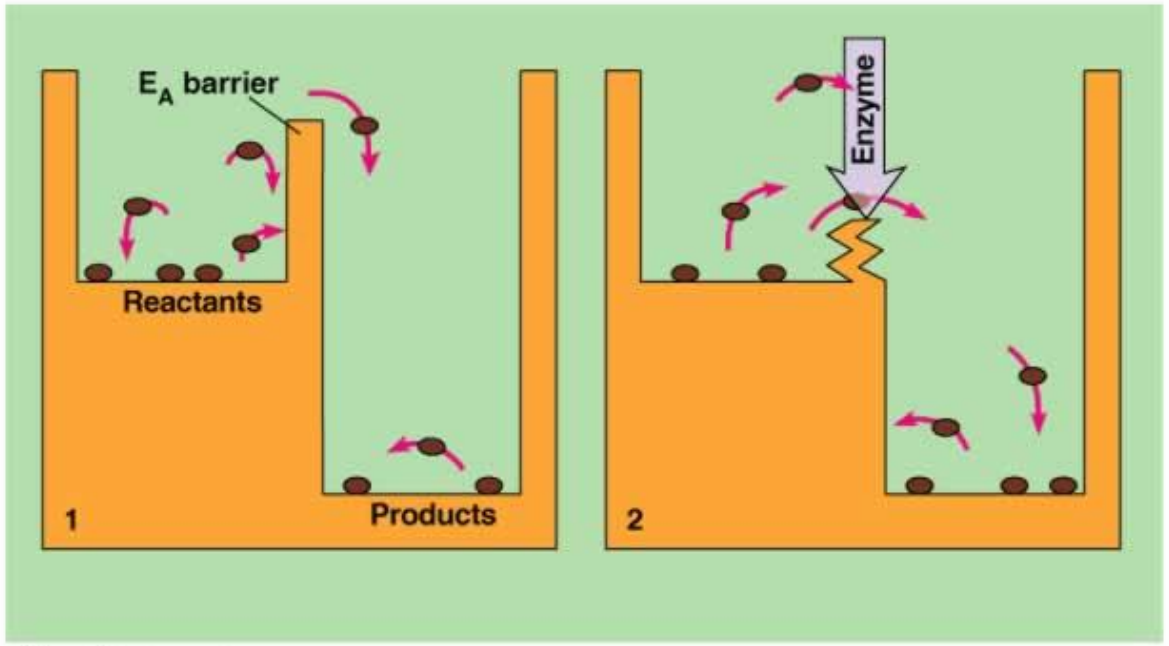
Increased temperature causes increased molecular motion causing a greater number of collisions per unit time resulting a higher reaction rate.

Catalysts Reduce the Energy of Activation Resulting in a Greater Reaction Rate



Catalyst Reduce Energy of Activation

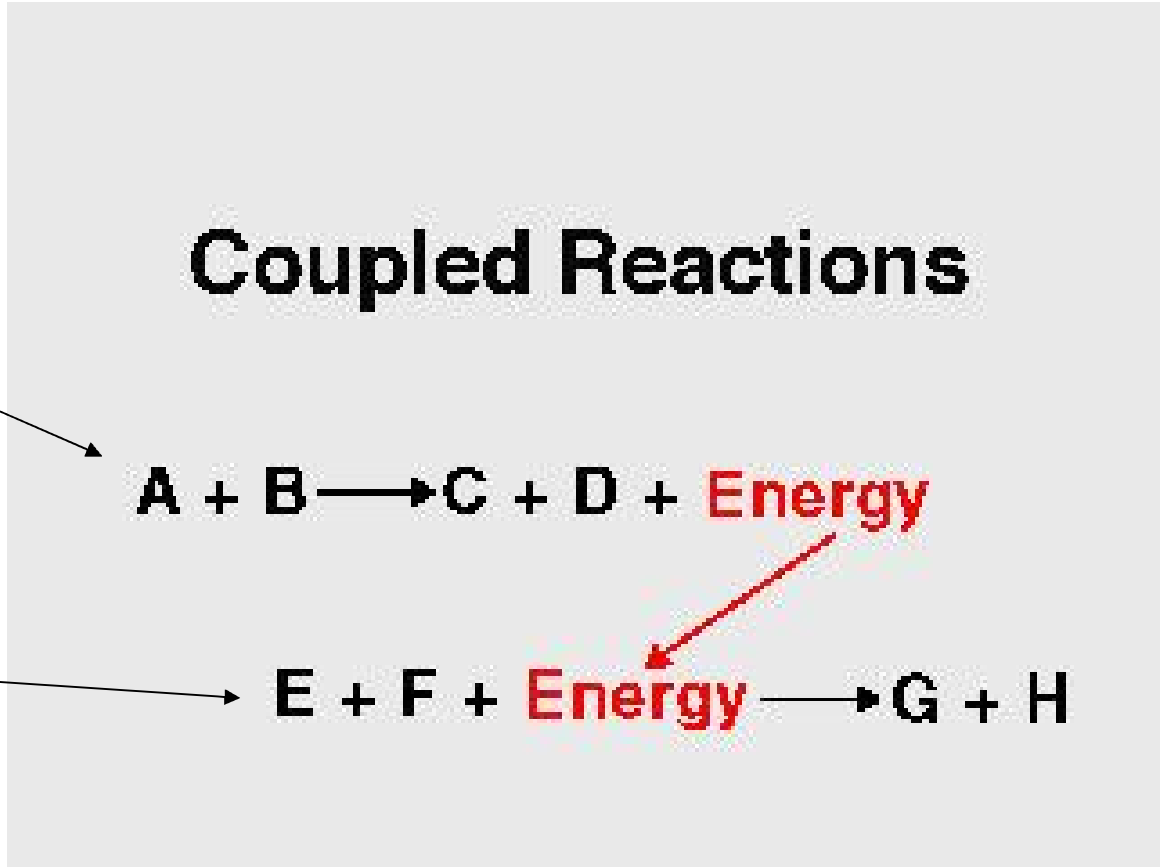




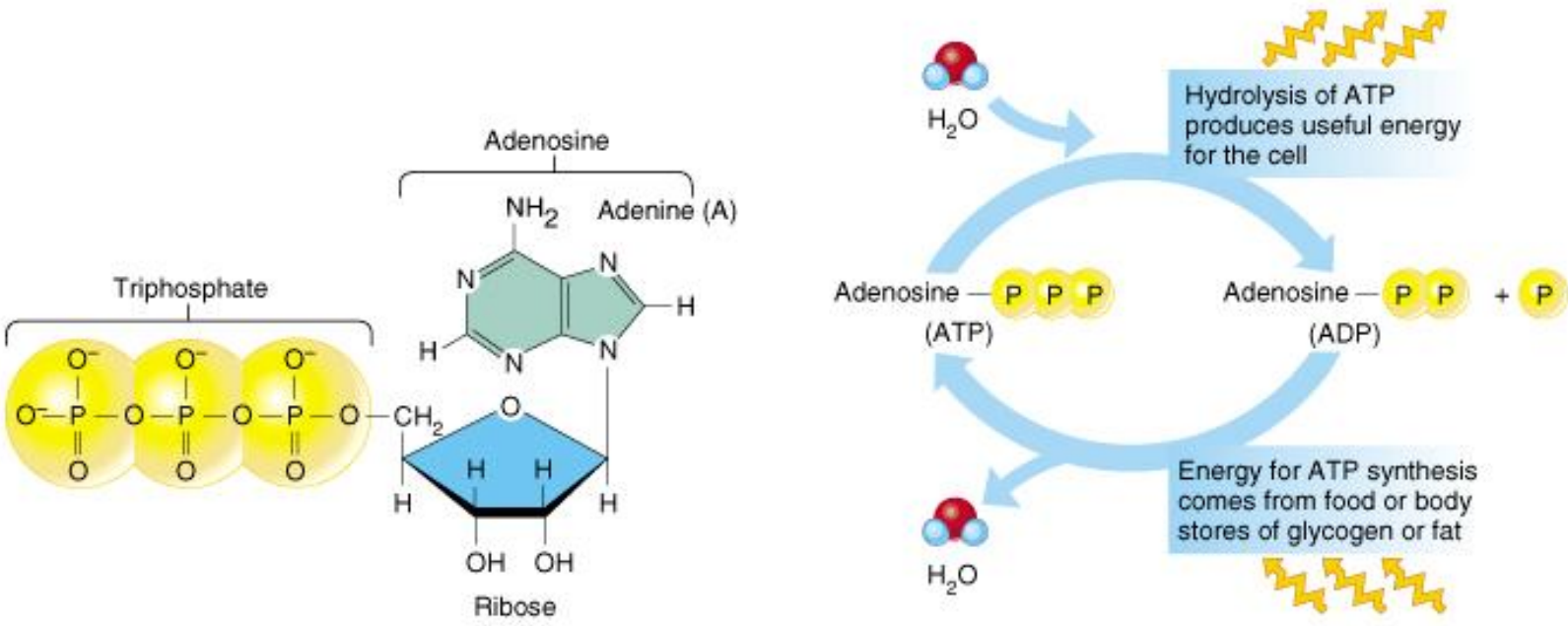
Energy Needed for Body Chemical Reactions

Food we eat

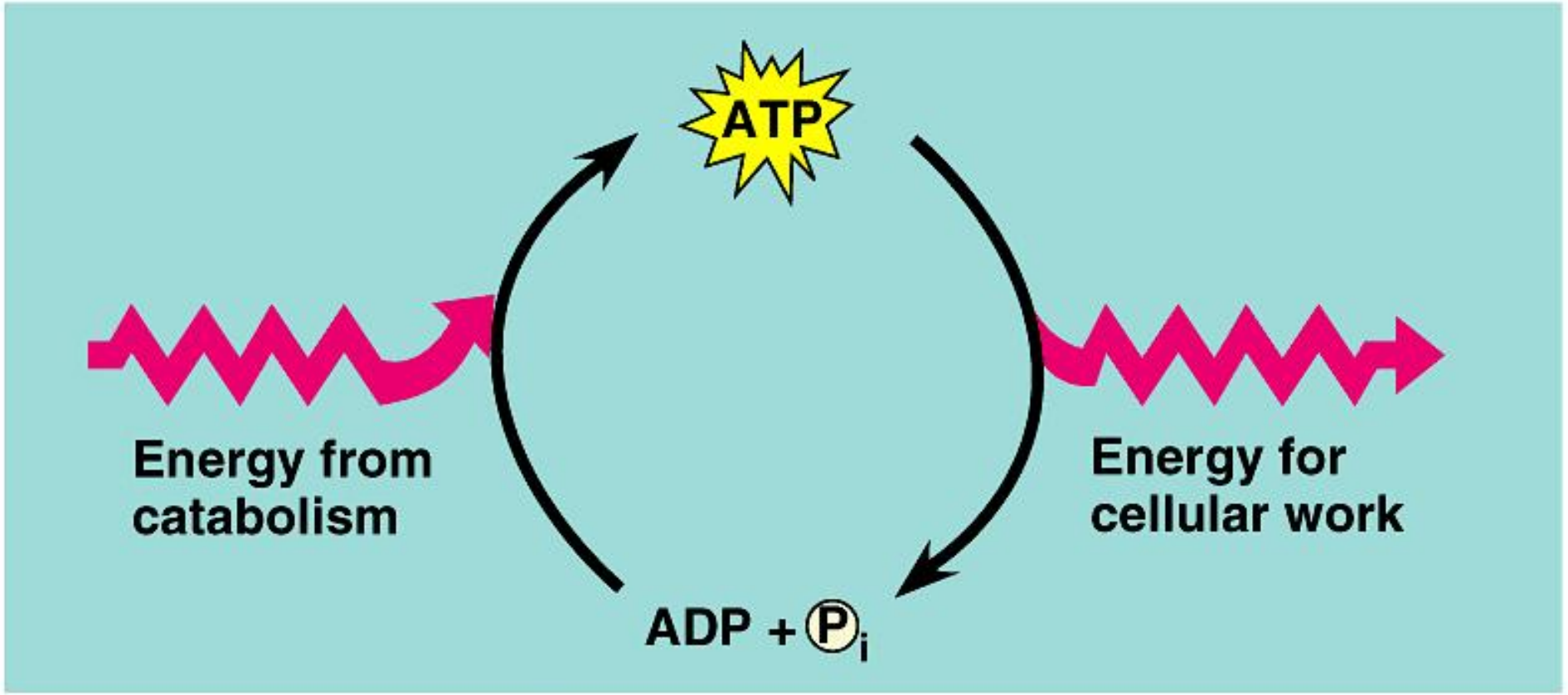
Body's chemical reactions



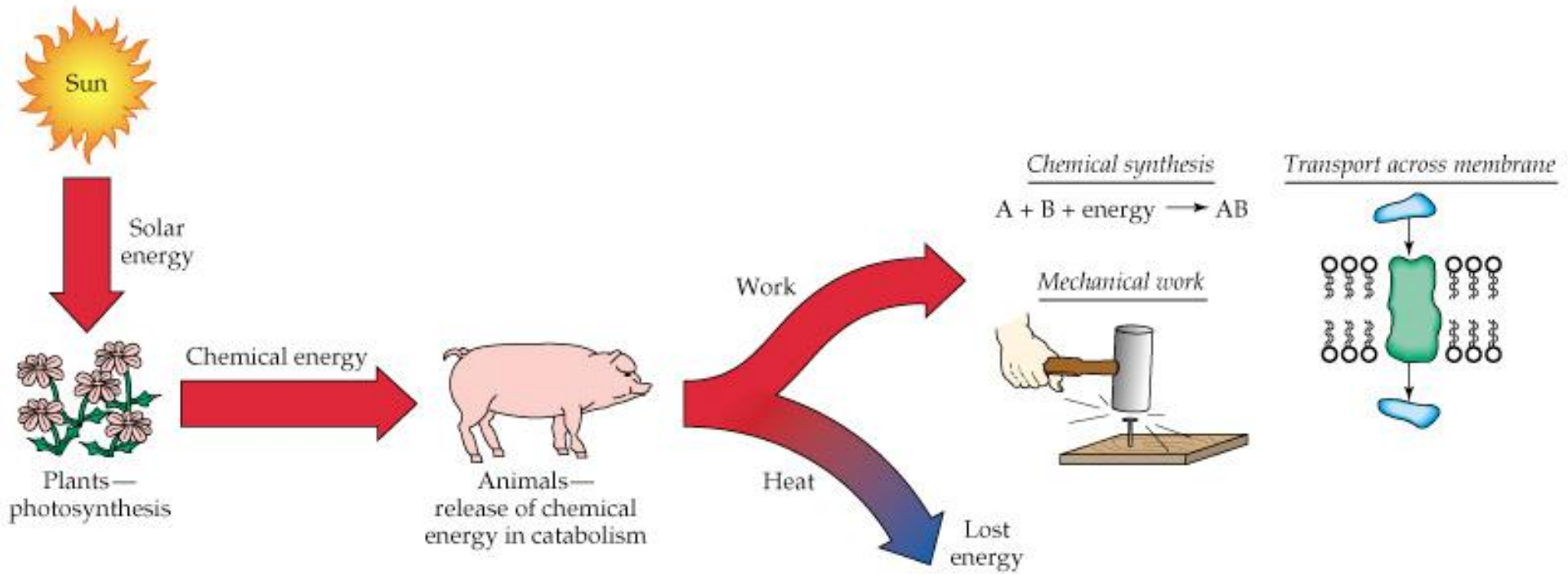
Energy for The Body's Chemical Reactions



Energy for The Body's Chemical Reactions



Energy For The Body's Chemical Reactions



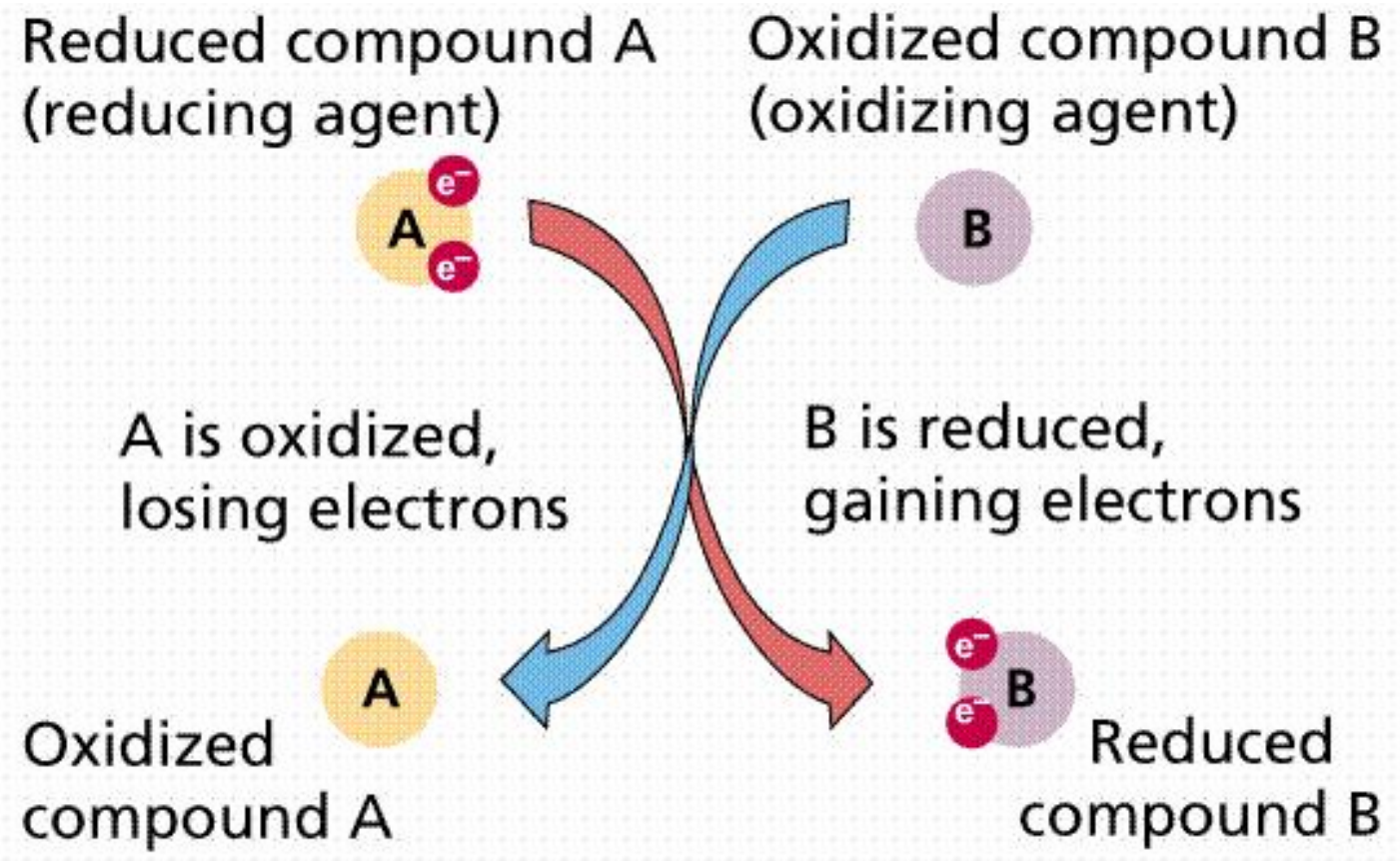
Physiological Chemical Reactions

- Metabolism- all the chemical reactions in the body
  - **Catabolism**- energy releasing decomposition reactions (exergonic reactions)
  - **Anabolism**- energy storing synthesis reactions (endergonic)
  - **Oxidation**- a reaction in which a molecule gives up electrons and releases energy

Physiological Chemical Reactions

- **Oxidation-** a reaction in which a molecule gives up electrons and releases energy
  - This molecule is said to be oxidized
- **Reduction-** a reaction in which a molecule gains electrons and energy
  - This molecule is said to be reduced
- Oxidation/Reduction reaction exist together

Oxidation/Reduction (Redox)



Chemical Compounds and Life Processes

The body's chemical compounds are divided into two major classed

1. Inorganic- usually small and lacks carbon and may contain ionic bonds

   Ex. Water (most abundant), oxygen, carbon dioxide, acids and bases

2. Organic- always contain carbon, mostly covalent bonds

   Ex. Proteins, lipids, carbohydrates, nucleic acids

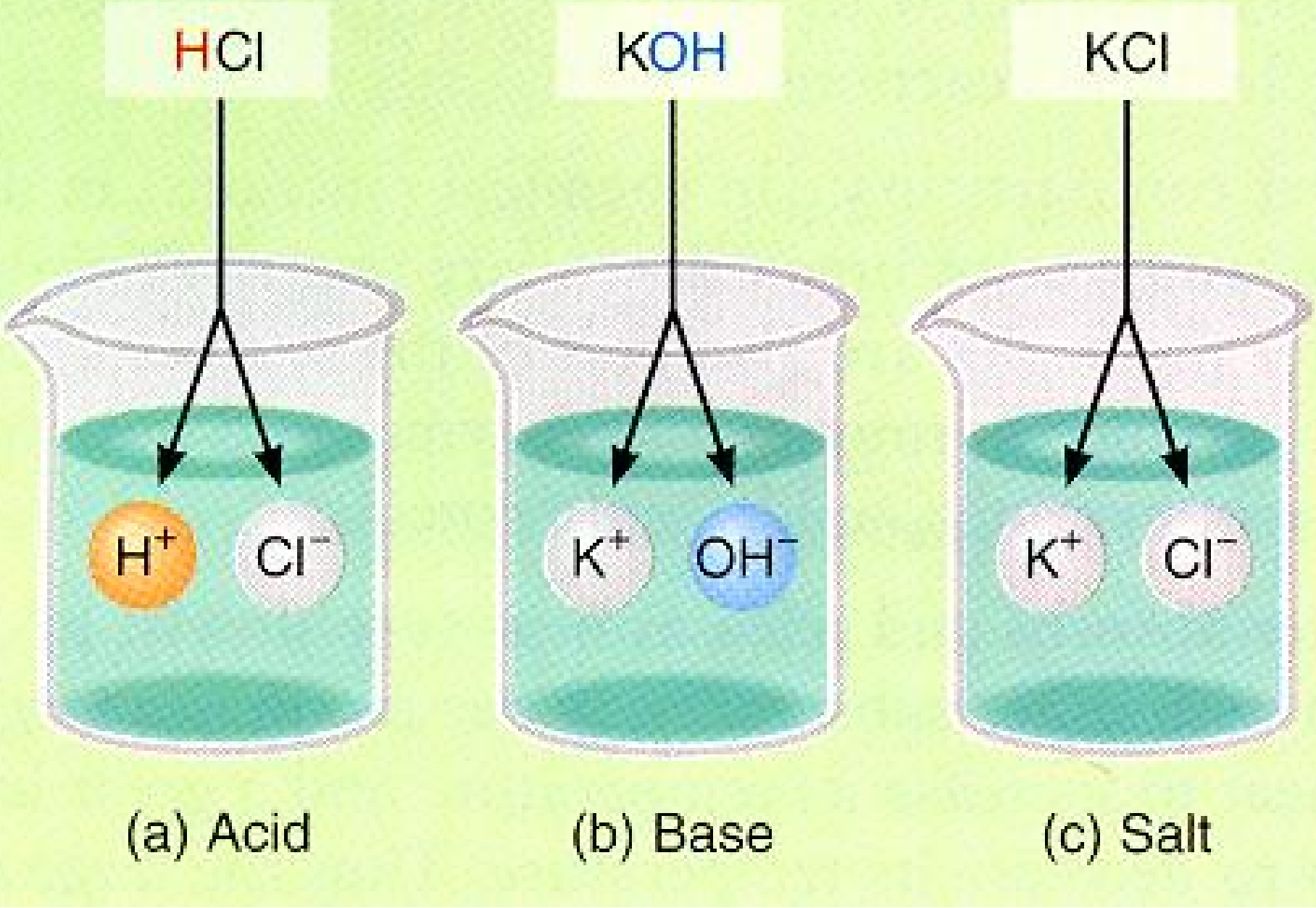
Inorganic Acids, Bases, and Salts

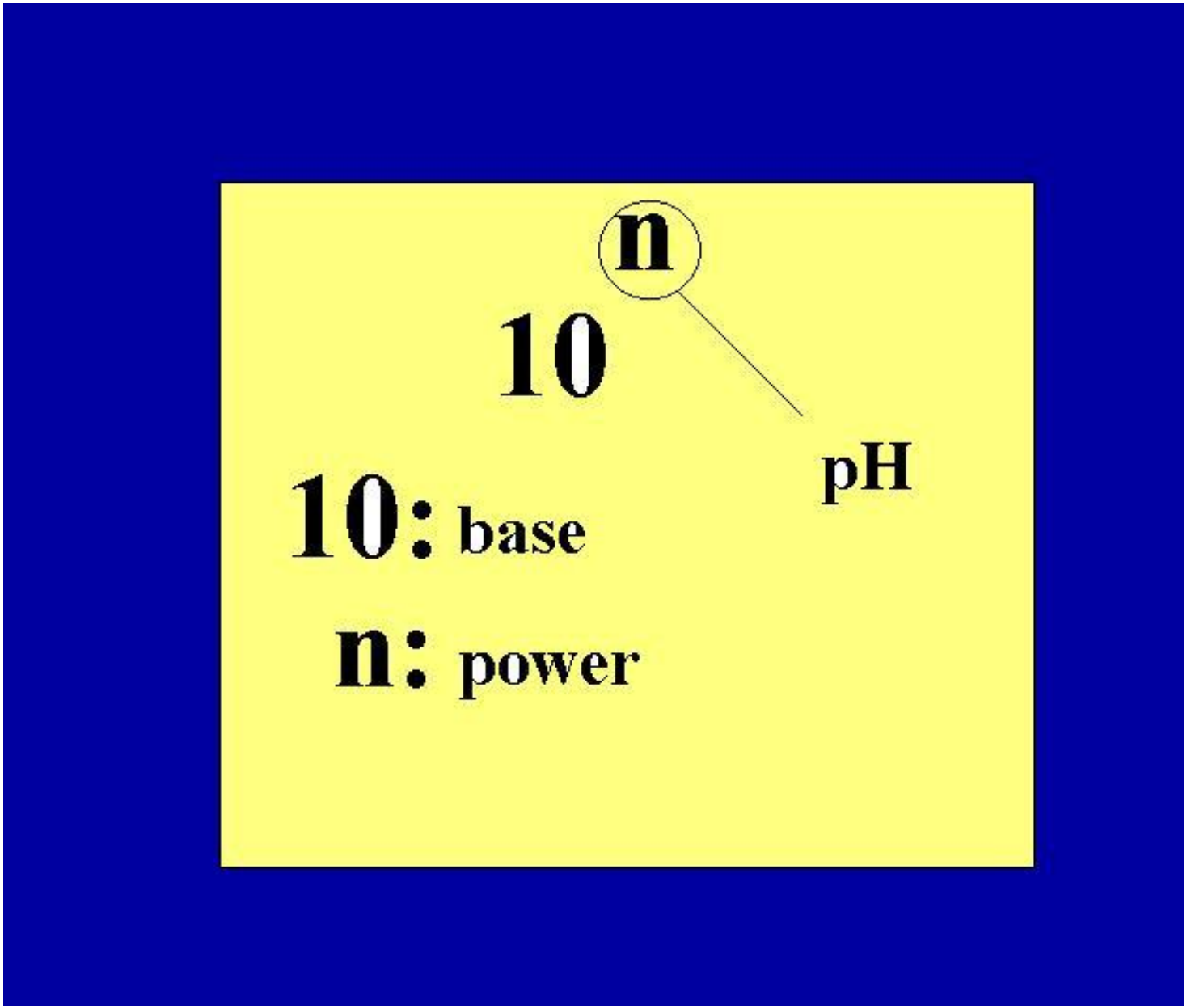
Ionization (dissociation)- the breaking apart of the inorganic molecule when dissolved in water

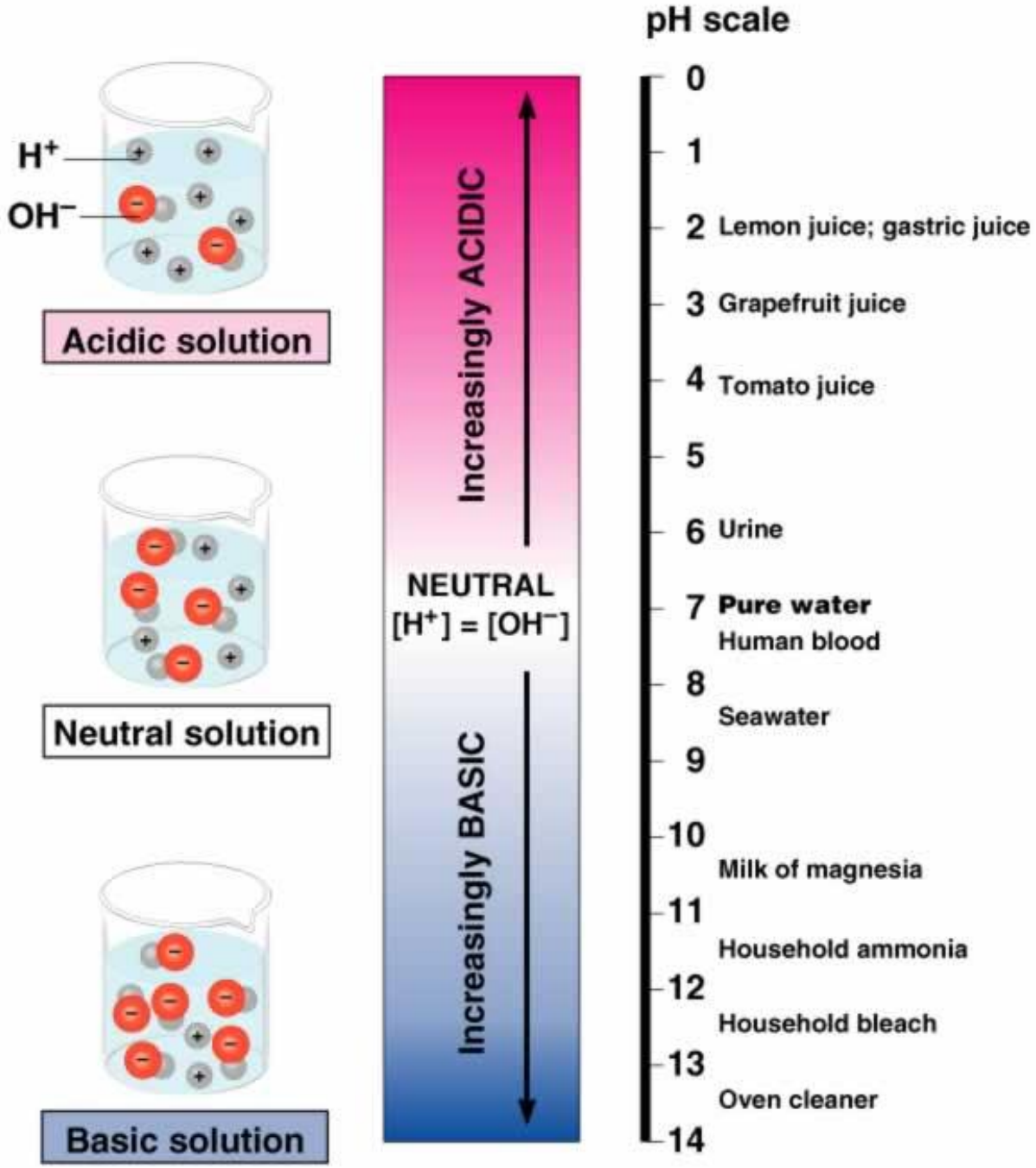
Acid- a substance that dissociates into H^+ and negative ions (anions)

Base- a substance that dissociates into OH^- (hydroxide) ions and a positive ion (cation)

Salt- a substance that dissociates into a cation and anion, neither of which is H^+ or OH^-


HCl
KOH
KCl
H+
Cl−
K+
OH−
K+
Cl−
(a) Acid
(b) Base
(c) Salt


n
10
pH
10: base
n: power



Maintaining pH: Buffer Systems

Compounds that prevent drastic changes in pH or Acid/Base balance

- Normal body pH is between 7.35 and 7.45
- acid base balance depends on the hydrogen ion concentration
  - majority of hydrogen ions are produced by the metabolic activity of the cell

  the CO_2 of respiration combines with water to form carbonic aced which dissociates into hydrogen and bicarbonate ions

$$CO_2 + H2O \longrightarrow H_2CO_3 \longrightarrow H^+ + HCO_3^-$$

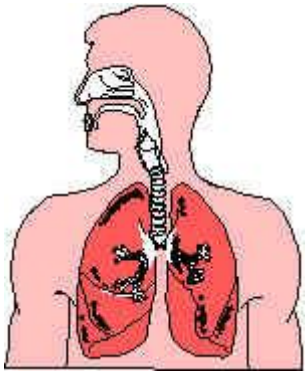
Buffers

Hydrogen ions can also be introduced into the body by other chemical compounds that we consume (whether nutritious or caustic).

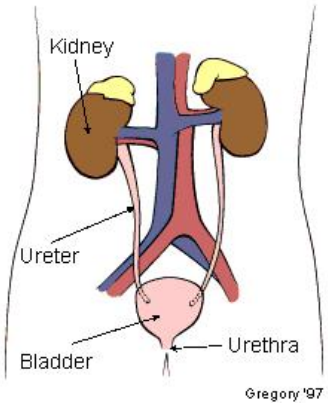
Buffer Systems consist of weak acids and weak bases that function to prevent drastic changes in the pH by strong acids and strong bases.

Systems That Control pH

- Respiratory System



- Urinary System



Buffers

Principal buffer systems

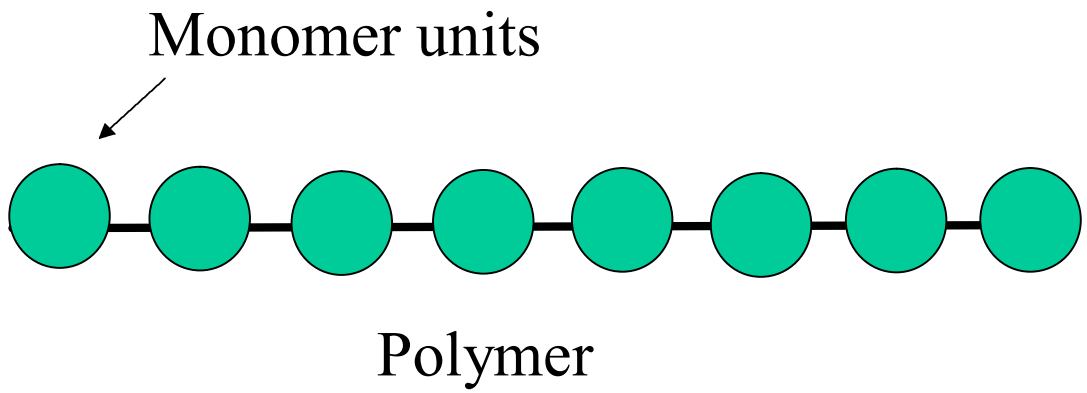
- carbonic acid-bicarbonate system
- phosphate system
- hemoglobin system
- protein system

Organic Compounds Macromolecules

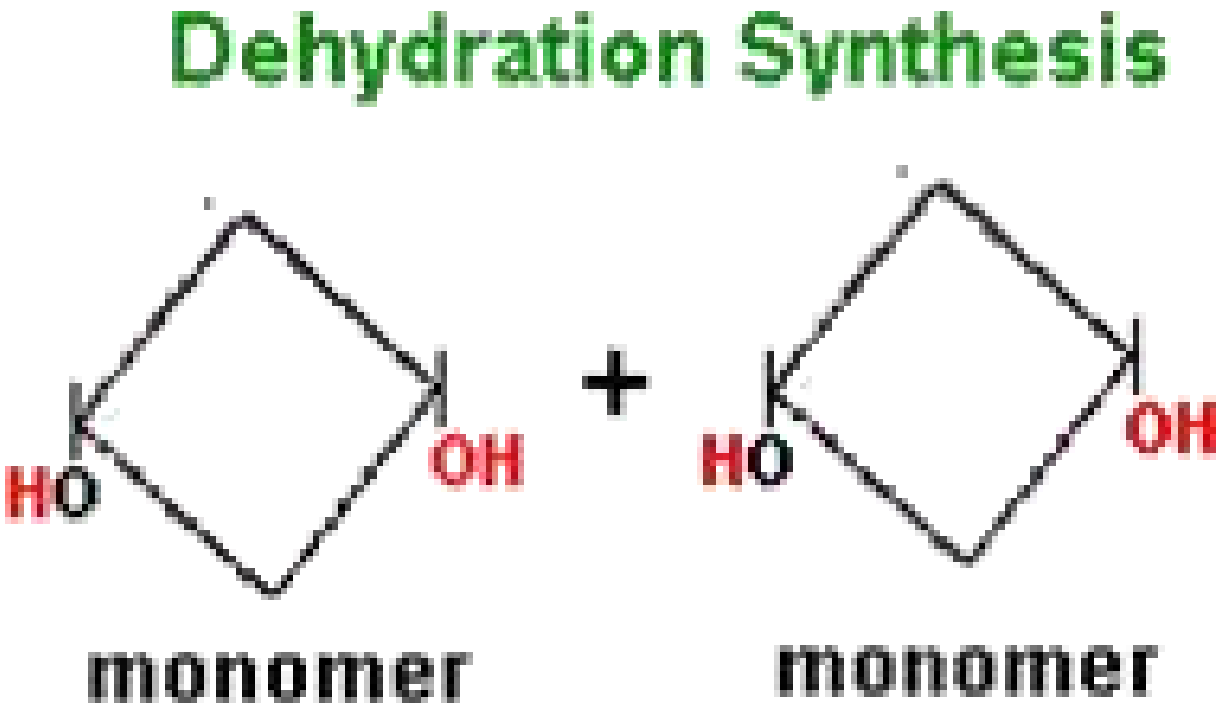
- Four major organic compounds of the body
  - carbohydrates
  - lipids
  - proteins
  - nucleic acids

Organic Compounds
Macromolecules

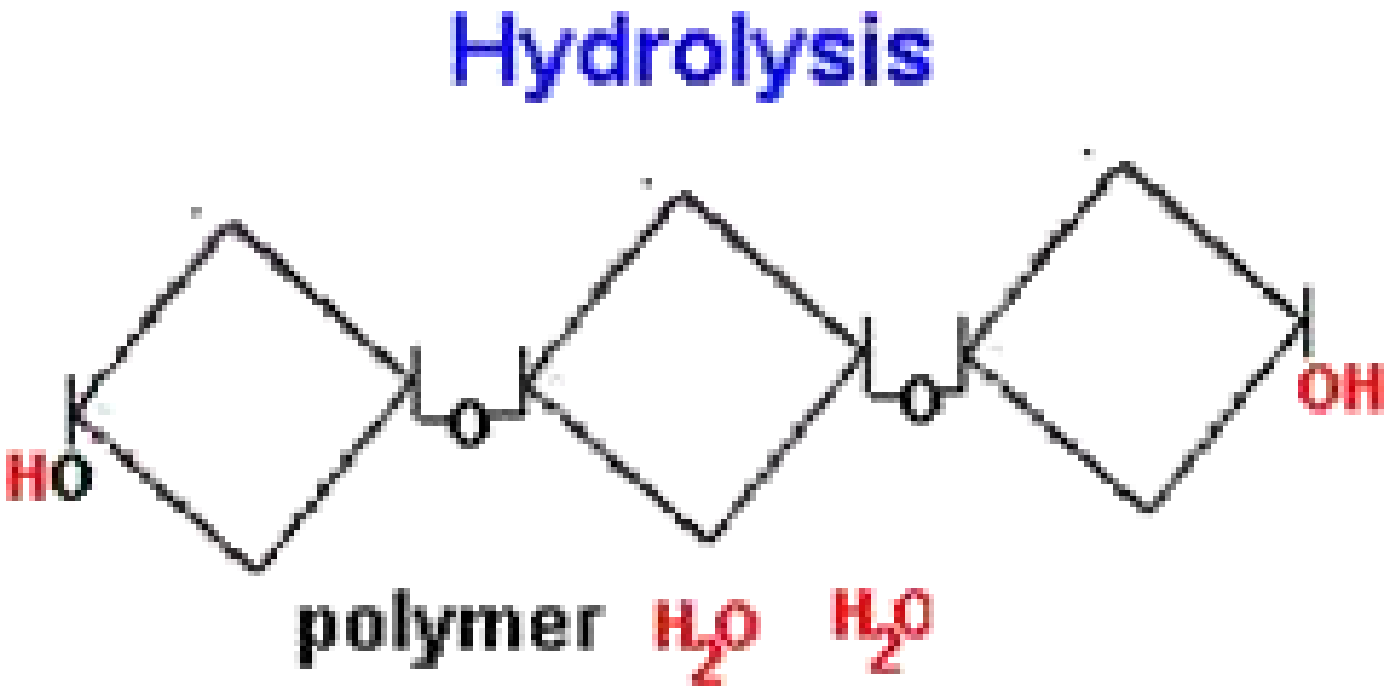
- Most of the macromolecules are made up of smaller monomer units to form polymers
- Dehydration reaction- building up
- Hydrolysis reaction- breaking down



Dehydration Synthesis Combines Monomers into Polymers

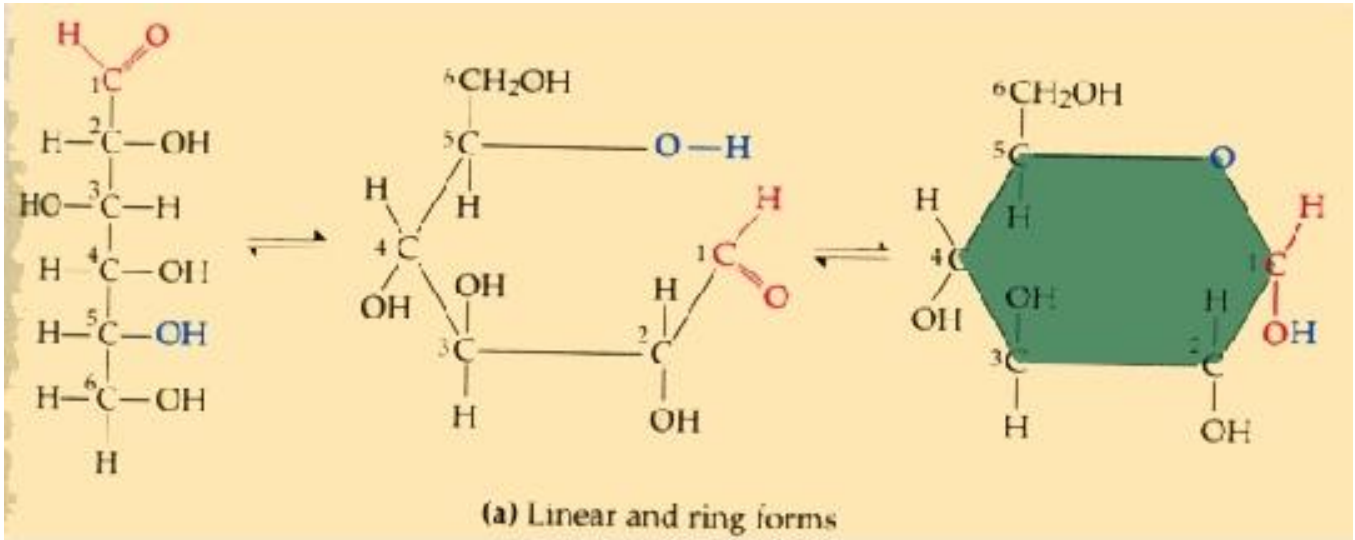


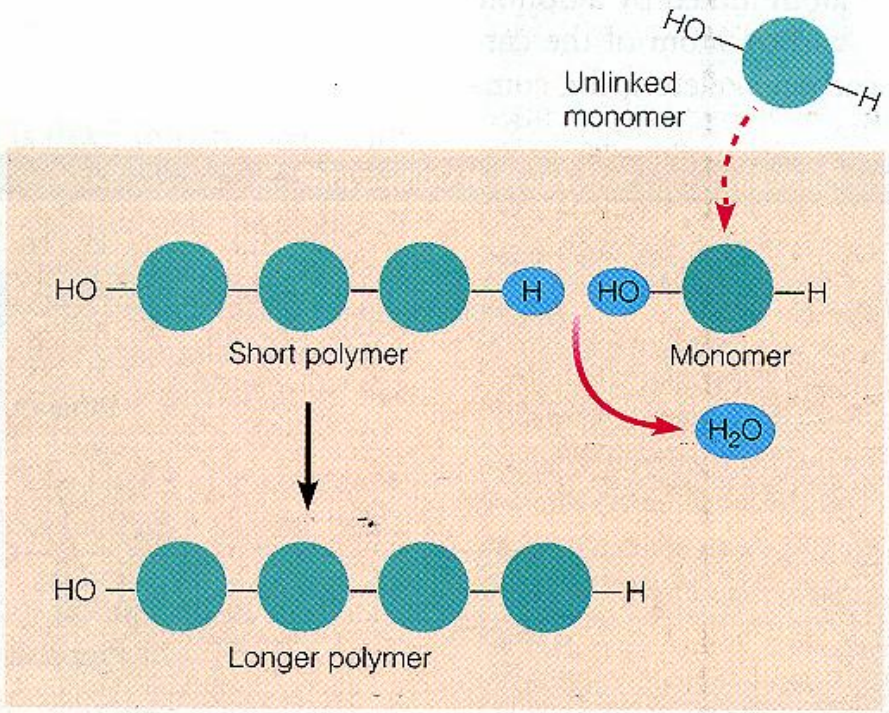
Hydrolysis Breaks Polymers Into Monomer Units



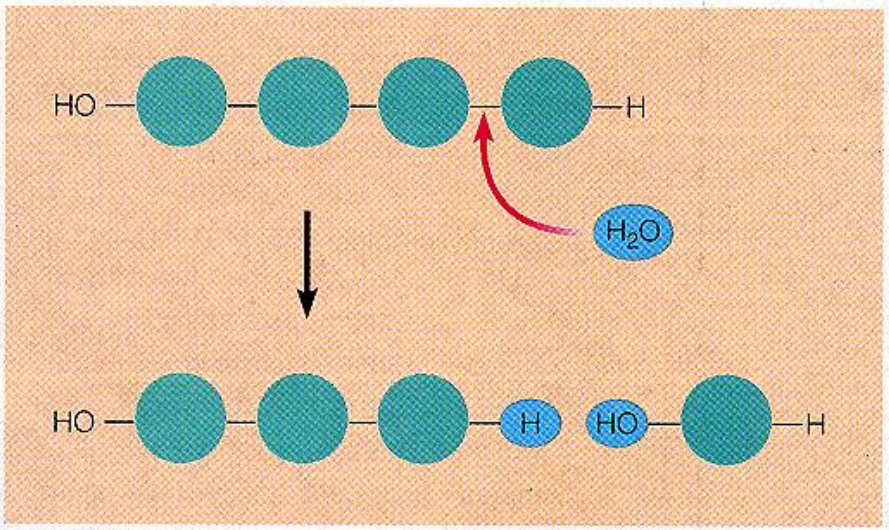
Carbohydrates

- Starches and sugars
- main use as energy source
- composed of a carbon, hydrogen and oxygen
  - oxygen to hydrogen ratio is 1:2
  - multiple of CH_2O Ex. Glucose ($C_6H_{12}O_6$)





A. Dehydration synthesis of a polymer



B. Hydrolysis of a polymer

Monosaccharide (simple sugar)

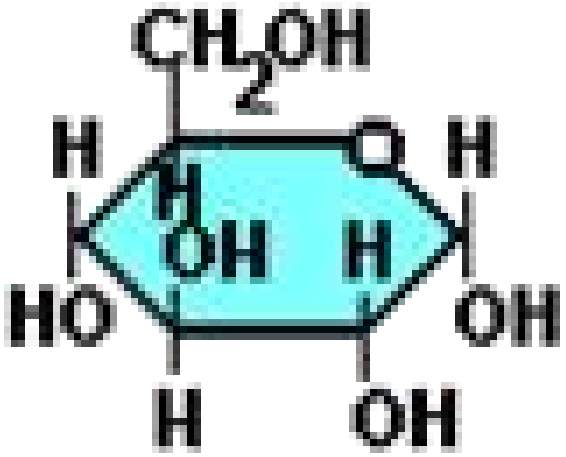
Polysaccharide (complex sugar)

Dehydration Synthesis

Hydrolysis (digestion)

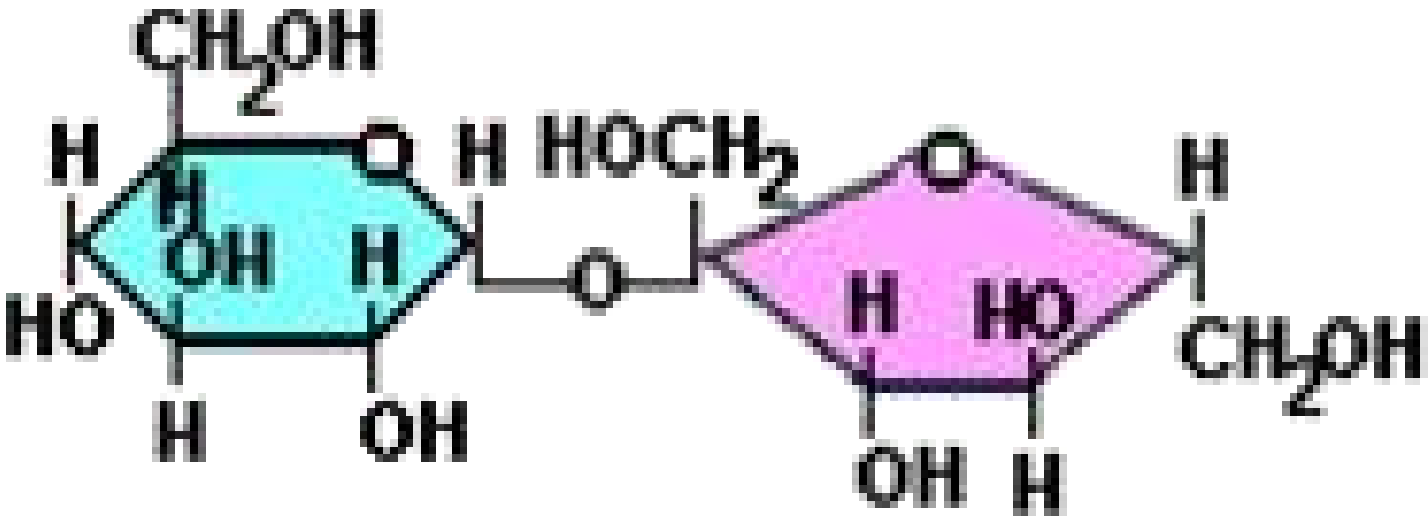
Forming Fructose From Glucose and Fructose

Dehydration Synthesis

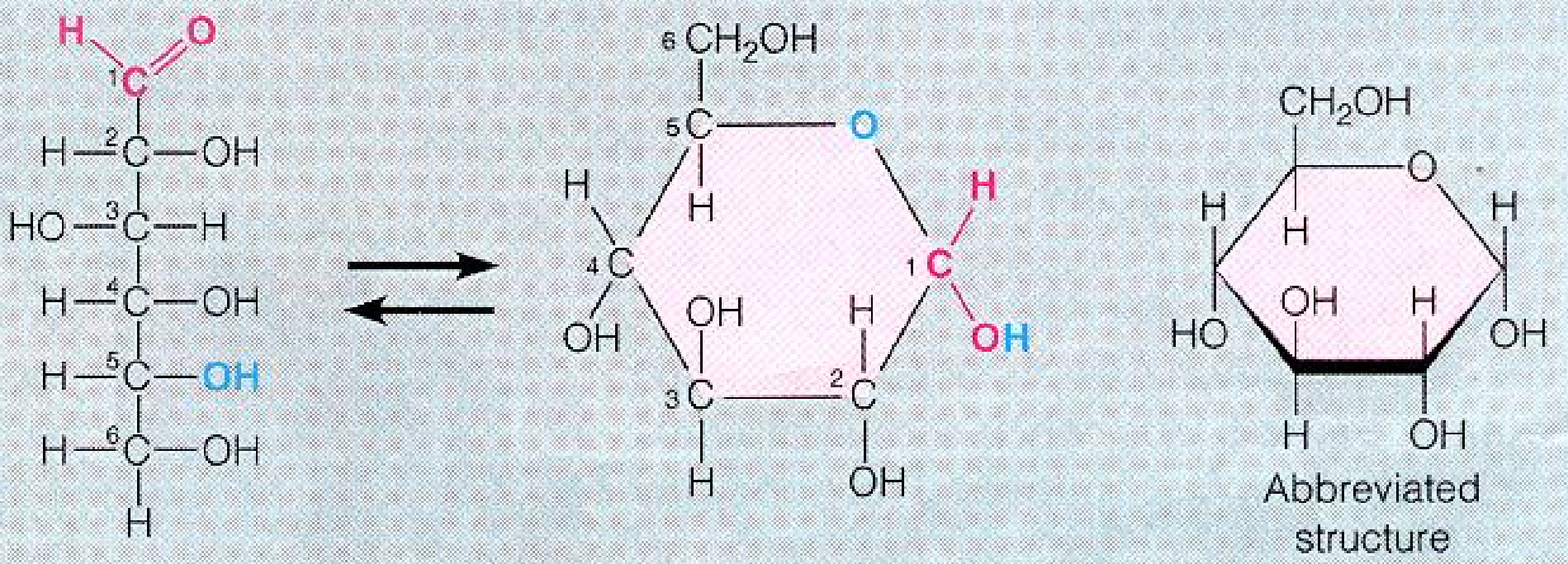


glucose

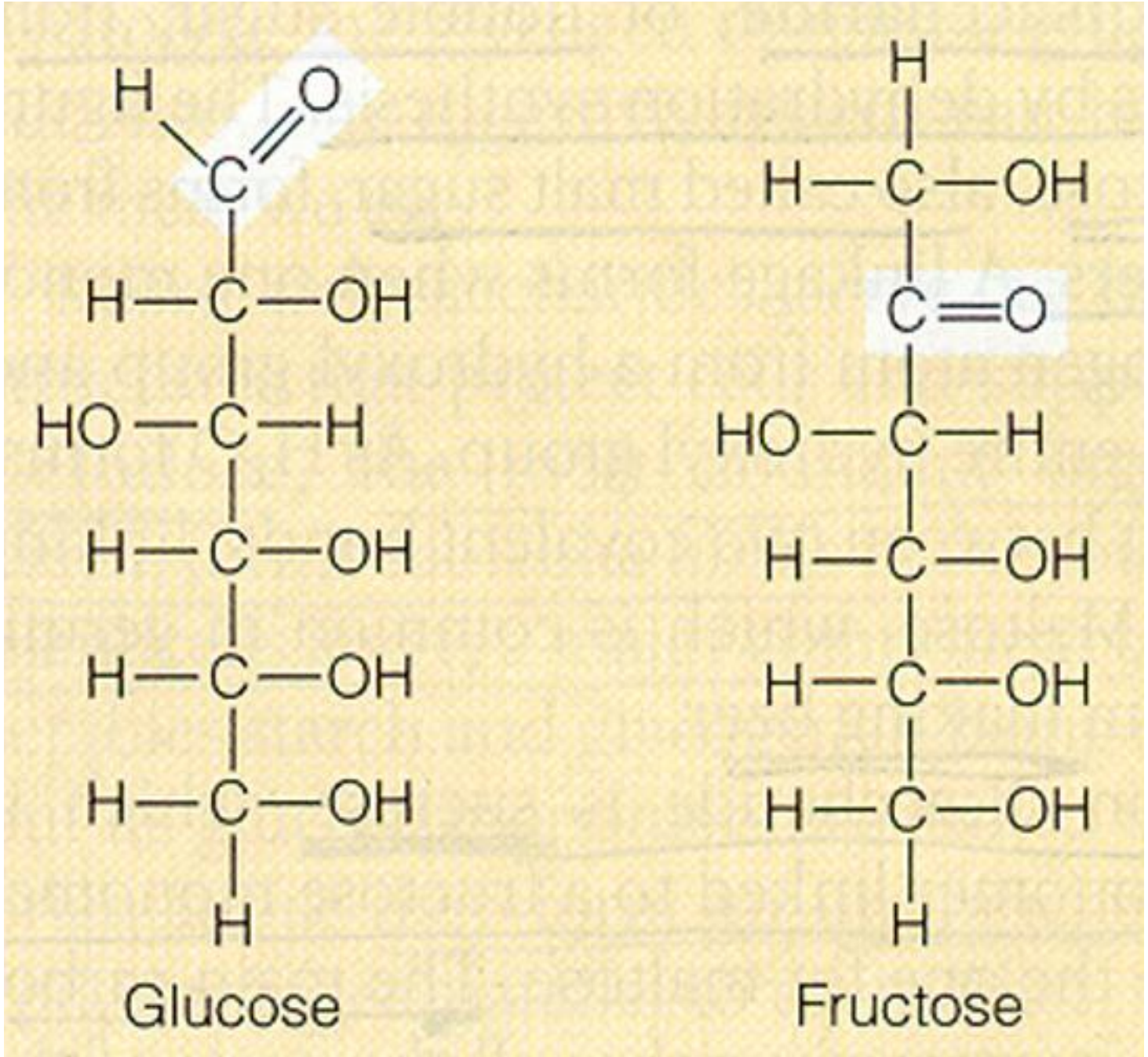
Hydrolysis



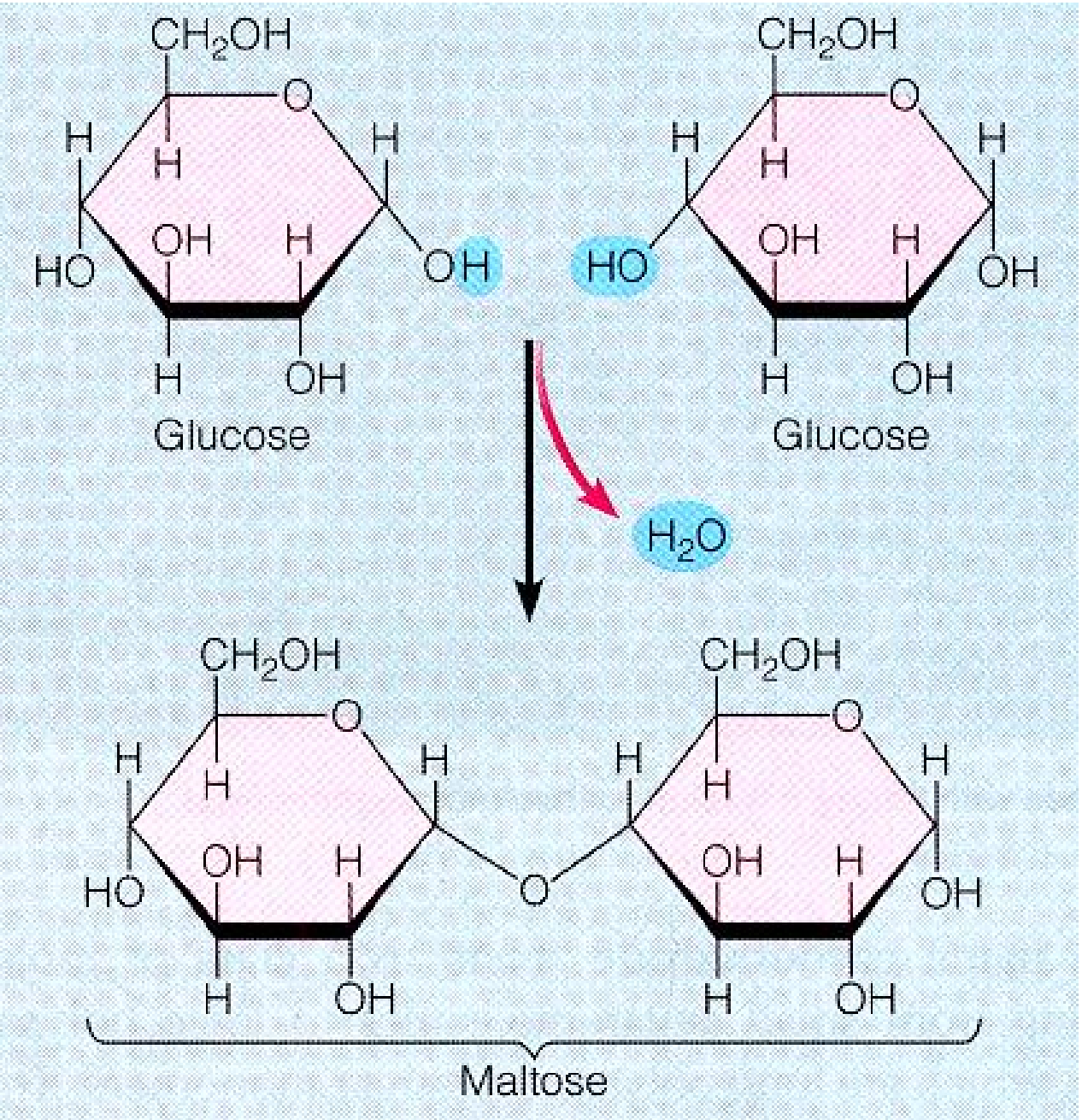
Sucrose + H_2O


Abbreviated
structure

Monosaccharides



Disaccharide

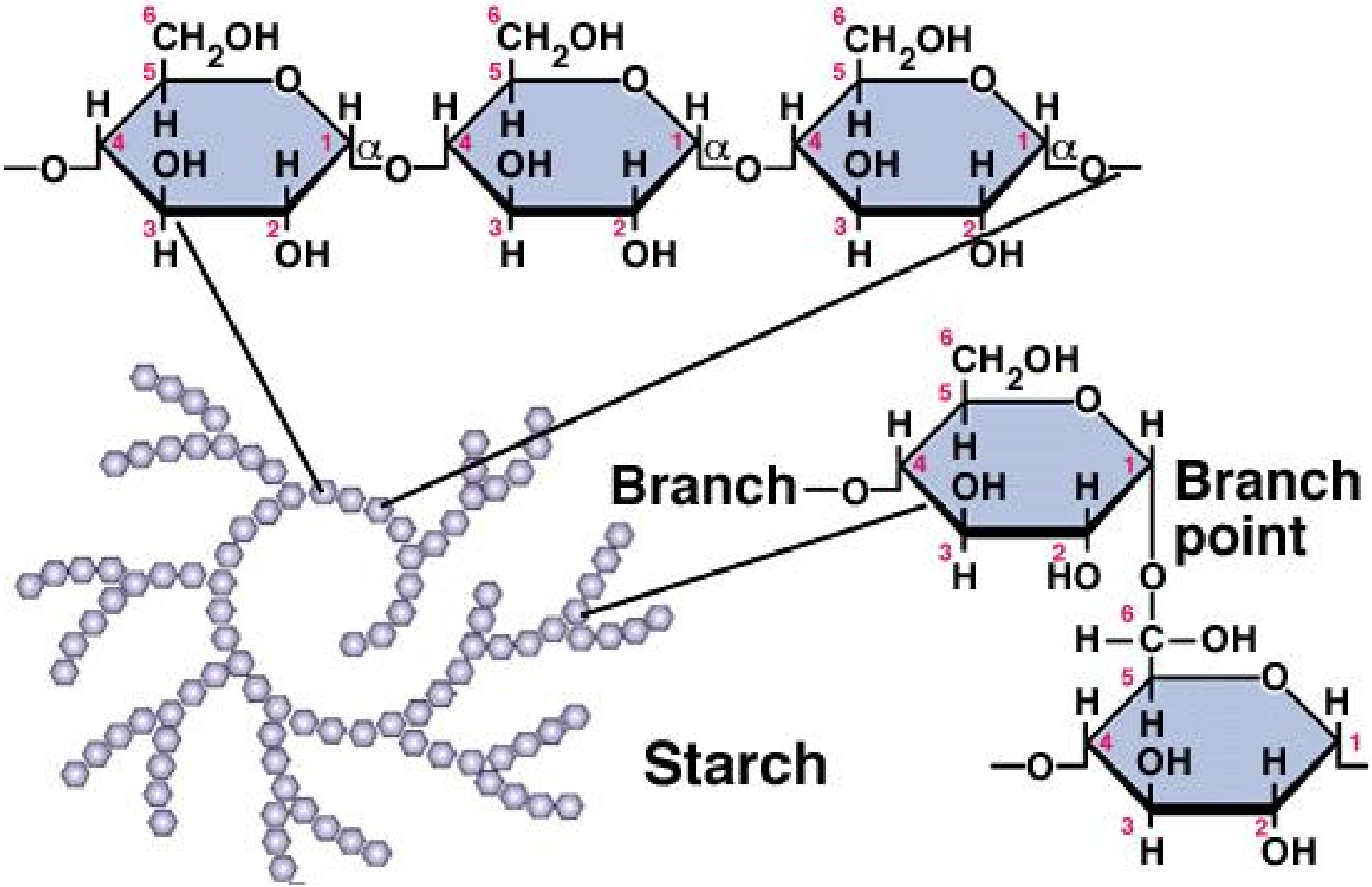


Maltose-2 glucose

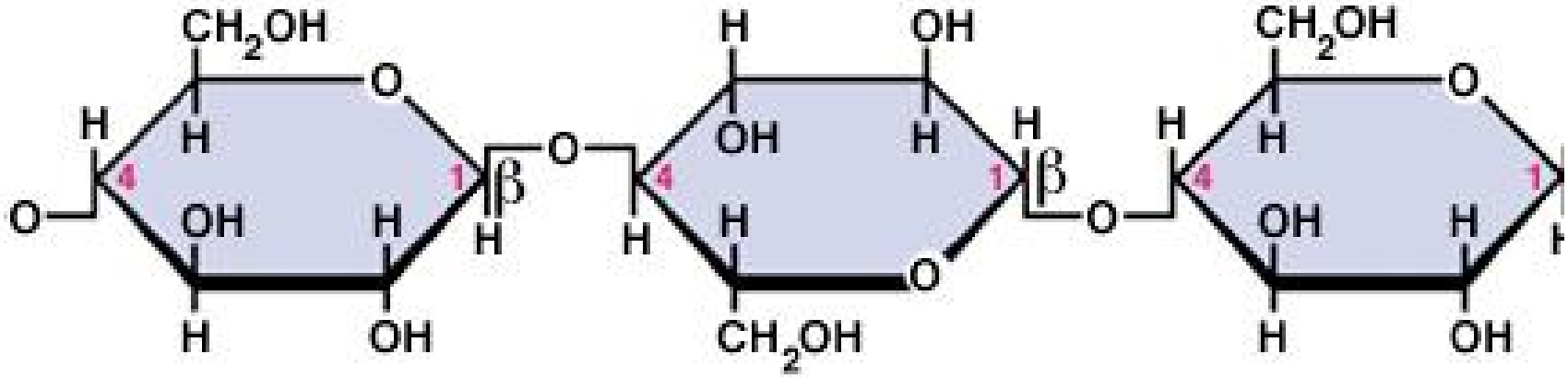
Sucrose- glucose and fructose

Lactose- glucose and galactose

Polysaccharides

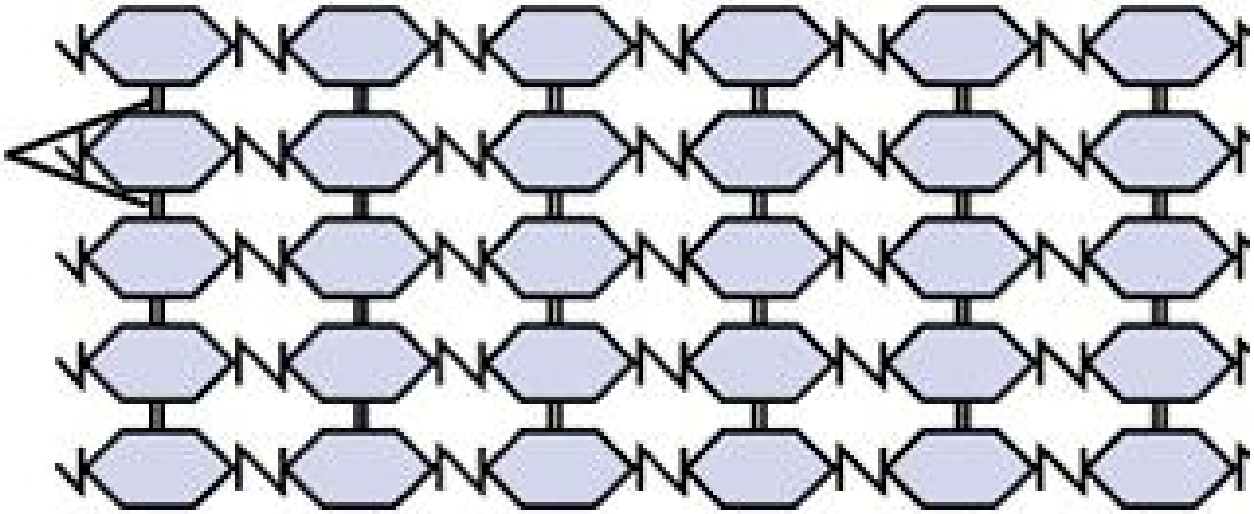


Polysaccharides

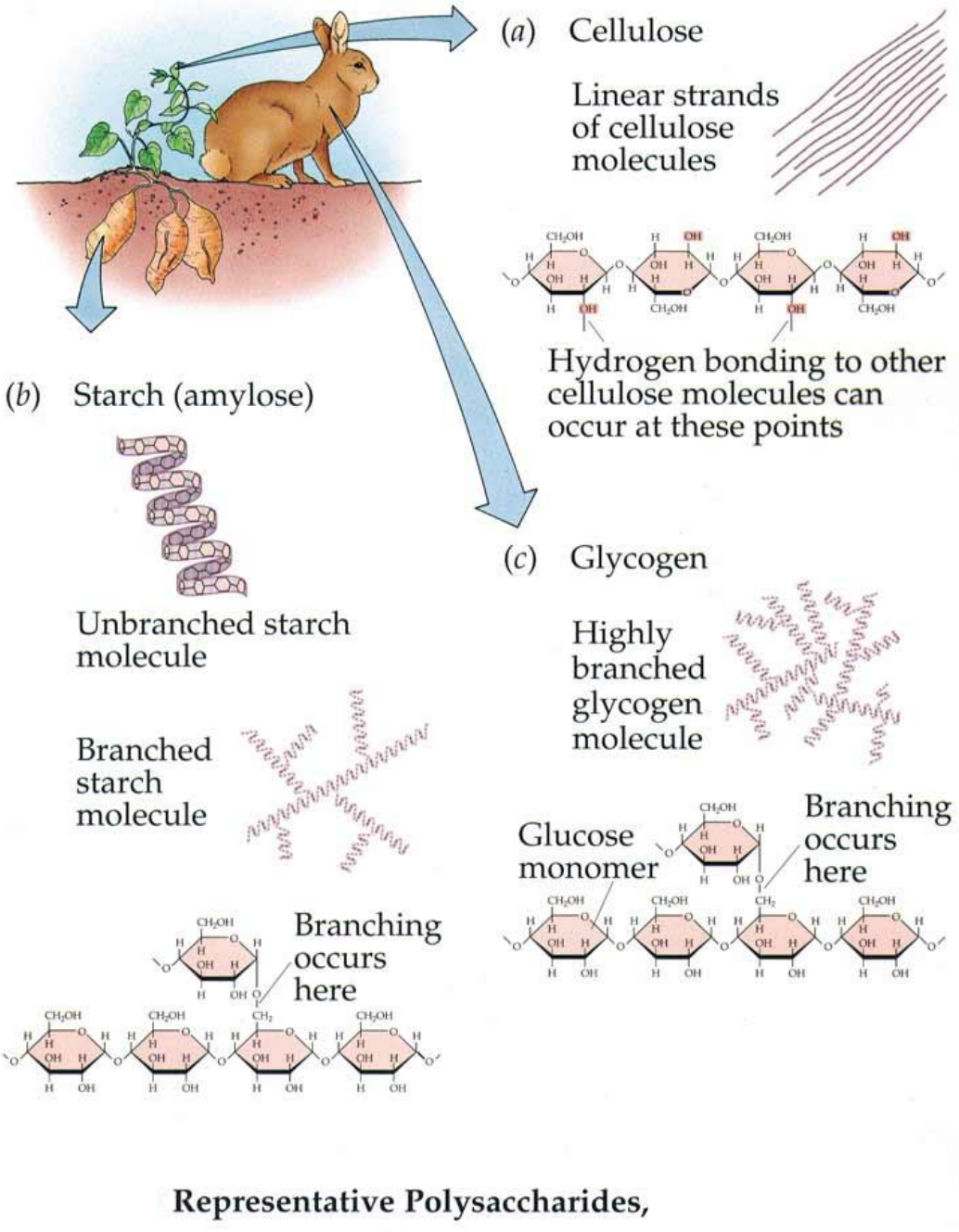


H bonds

Cellulose



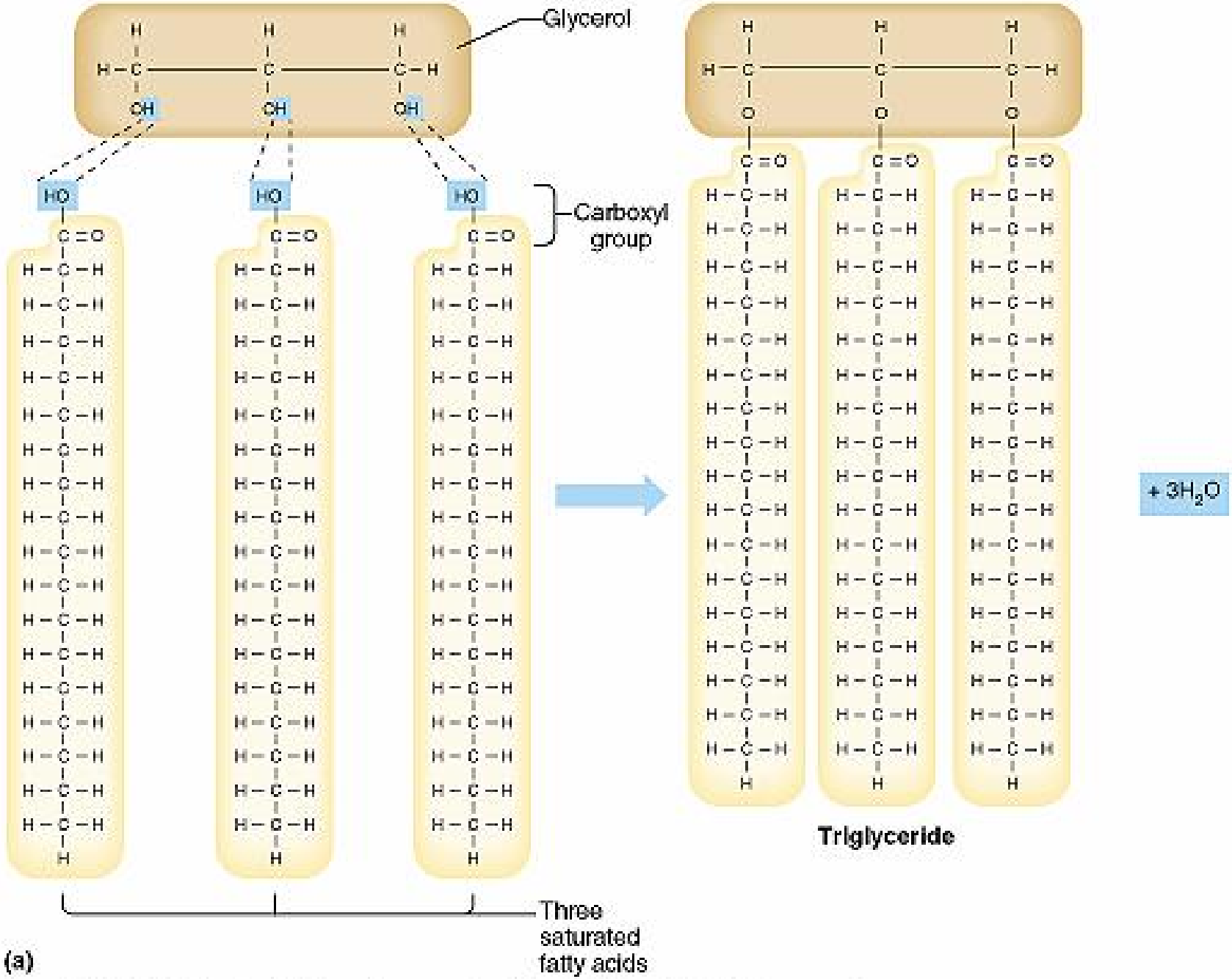
Storage Forms of Glucose



Representative Polysaccharides,

Lipids

- Composed of carbon, oxygen, and hydrogen
- Does not have 1:2 oxygen to hydrogen ratio
- noncharged
  - hydrophobic
  - hydrophillic
- Classes of lipids
  - triglycerides (fats and oils)- the bodies most highly concentrated source of energy over carbohydrates, however, less efficient.



Triglyceride

Glycerol

Fatty acid

Saturated fat

animal foods (meats, milk, eggs)

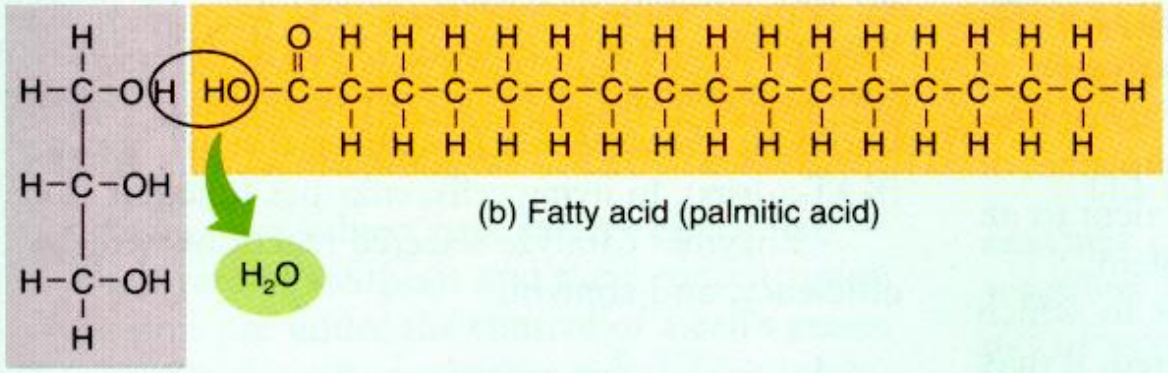
Unsaturated fats

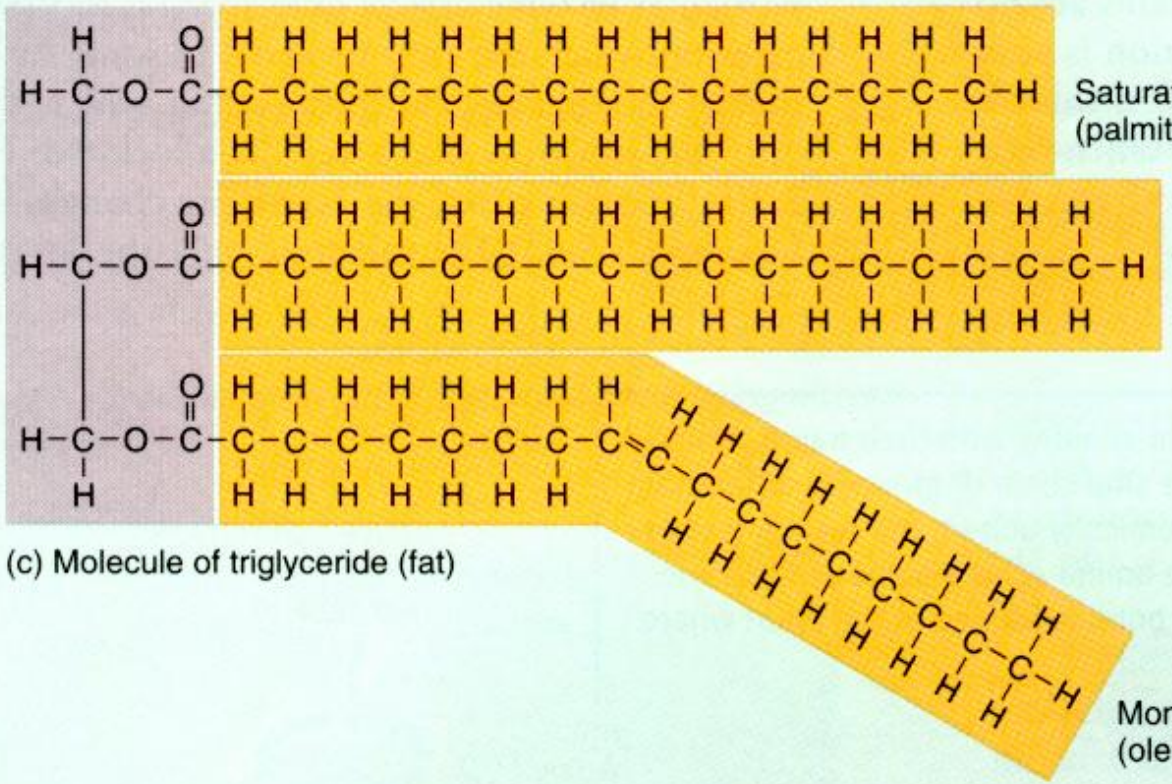
monounsaturated fat

olive oil, canola oil, peanut oil

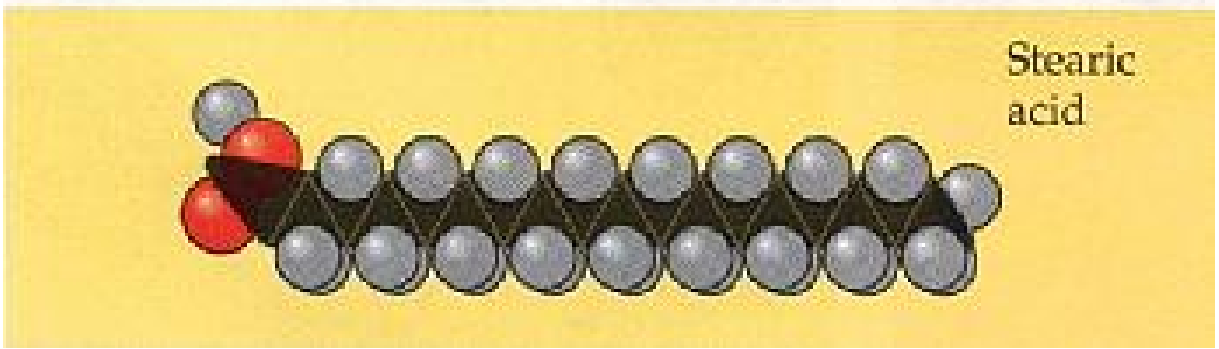
polyunsaturated fat

corn, dafflower, sunflower,cottonseed, sesame, soybean oils





Saturated Fatty Acids
Animal foods (meats, milk, eggs)



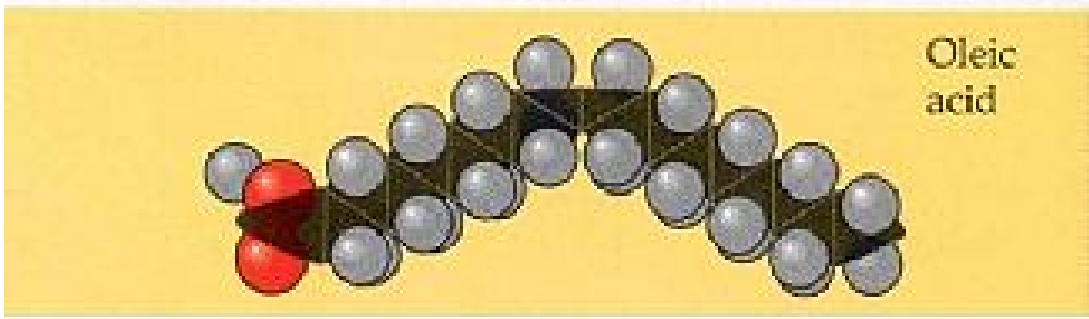
Unsaturated Fatty Acid

Monounsaturated fat

olive oil, canola oil, peanut oil

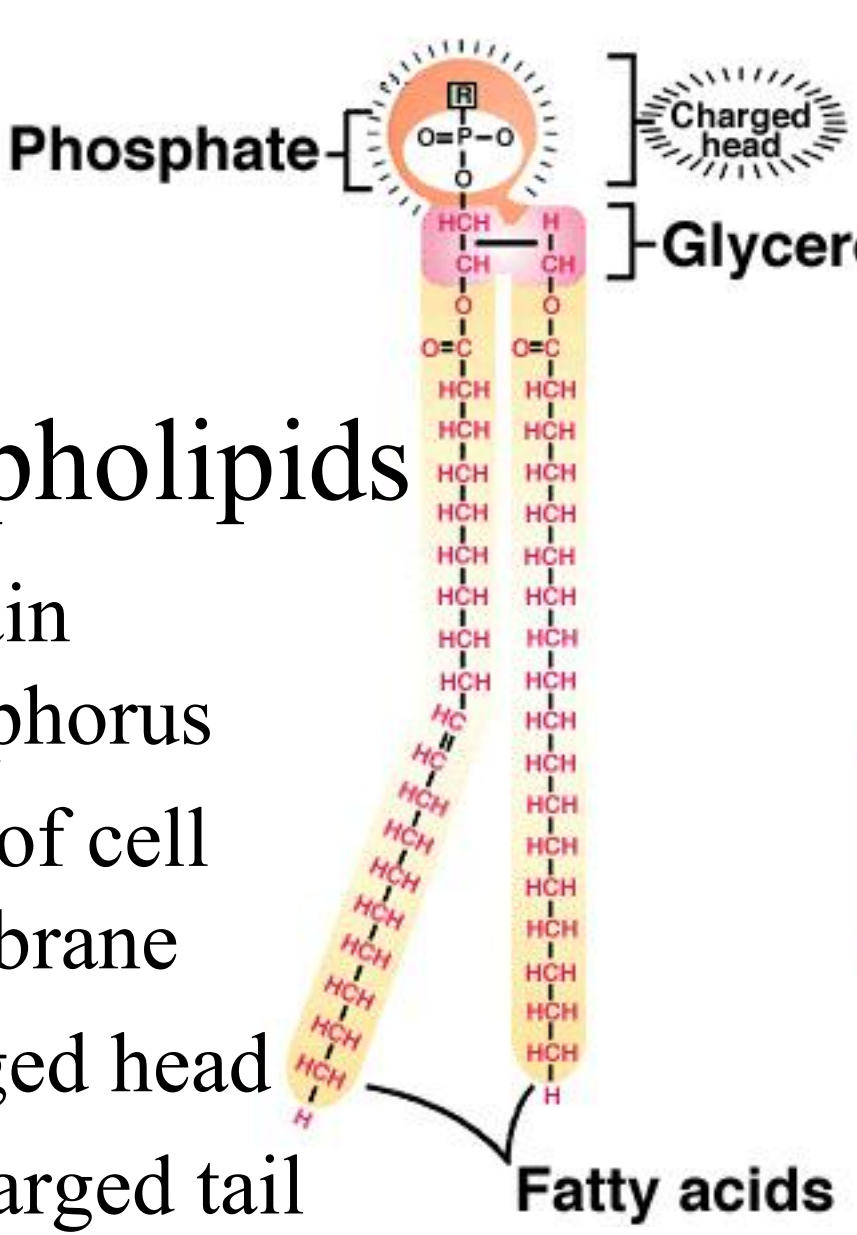
Polyunsaturated fat

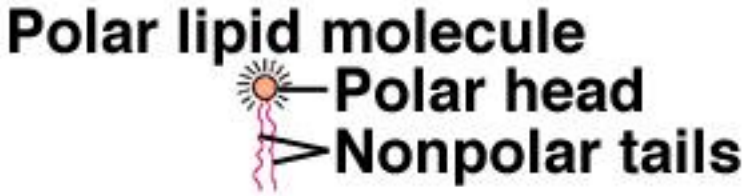
corn, dafflower, sunflower, cottonseed, sesame, soybean oils

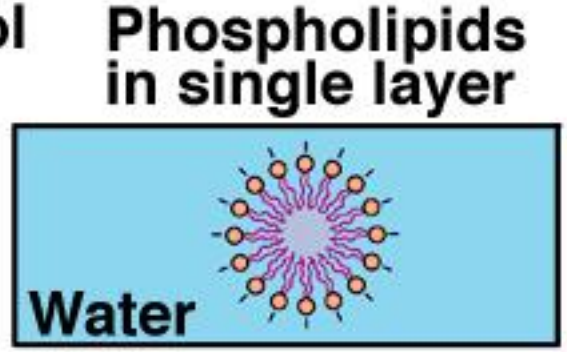


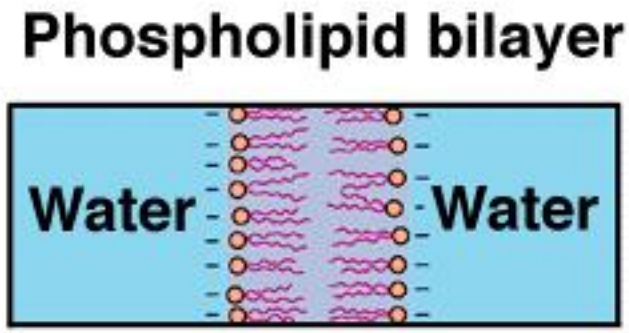
Phospholipids

- contain phosphorus
- part of cell membrane
- charged head
- uncharged tail



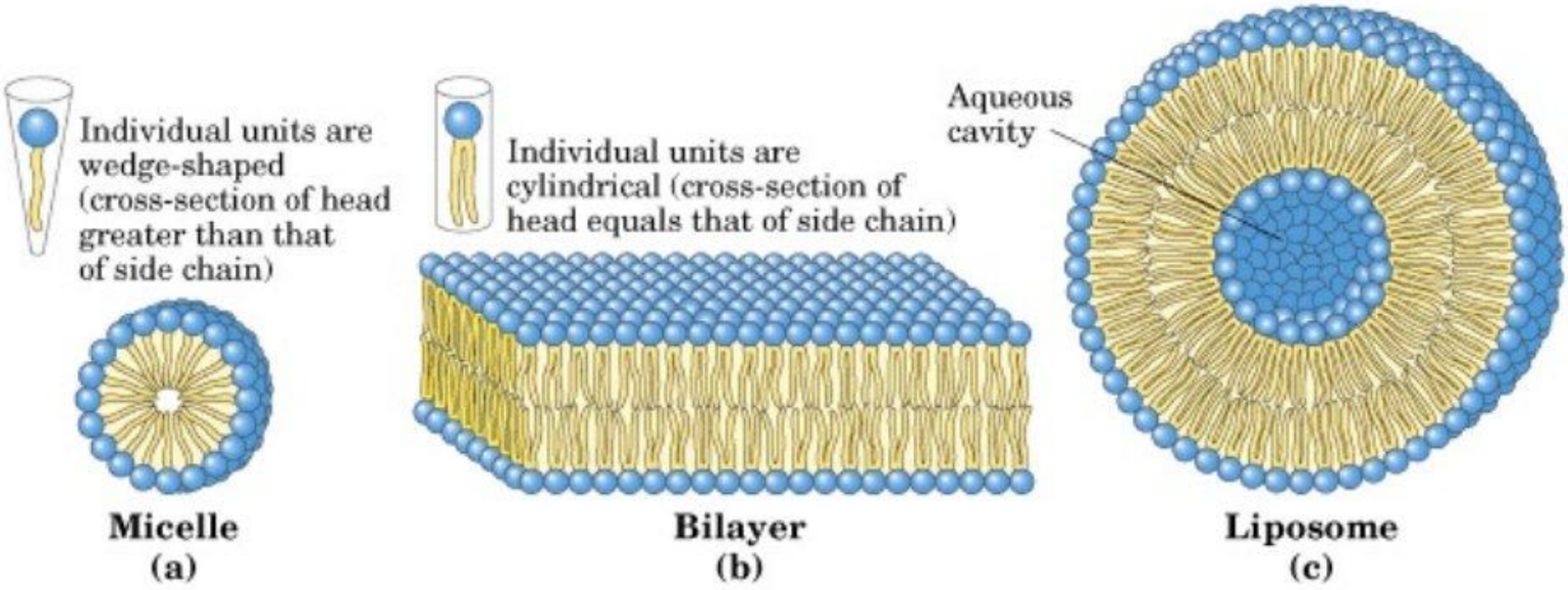


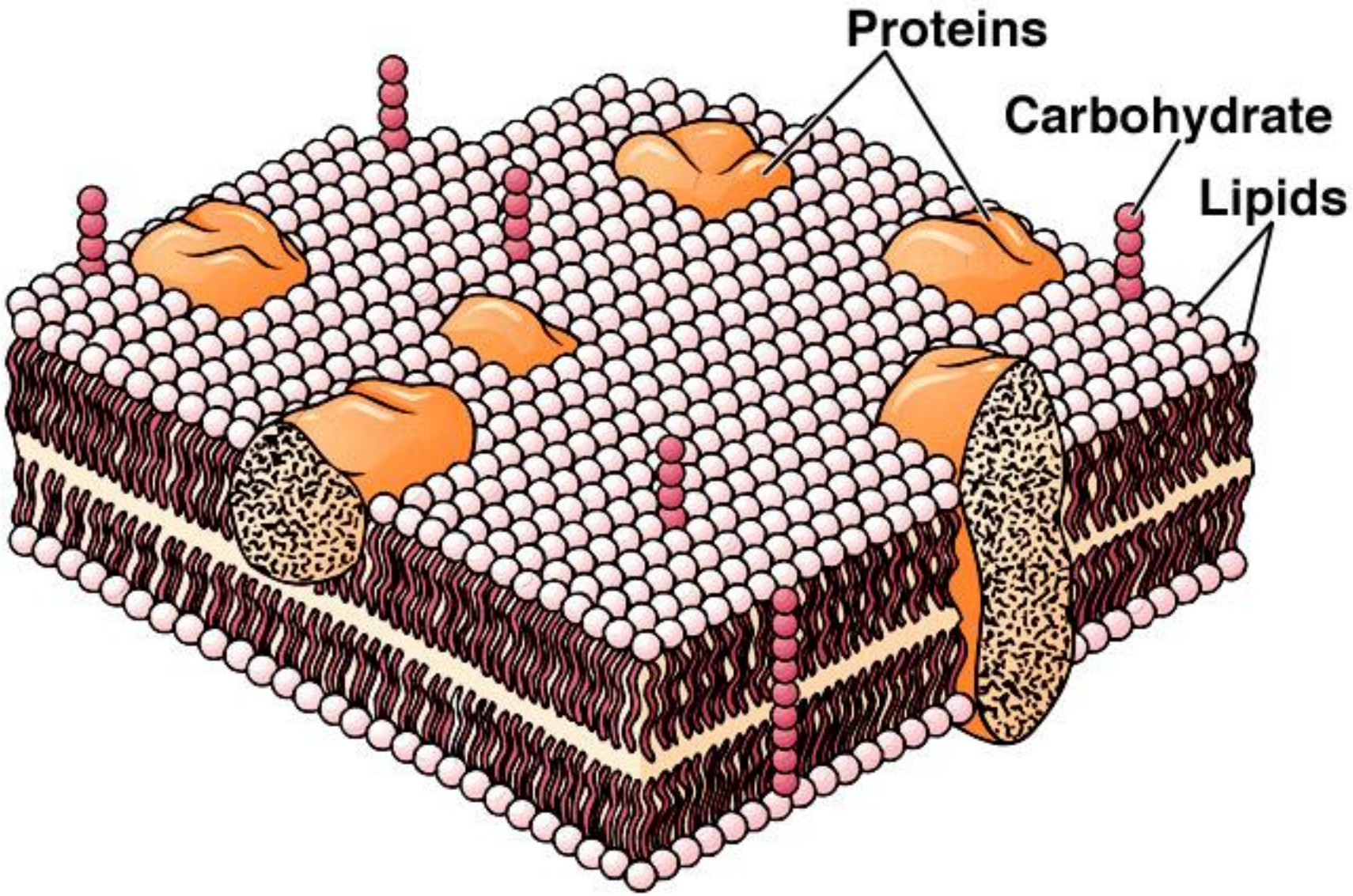




Phospholipids

Lipid Bilayers

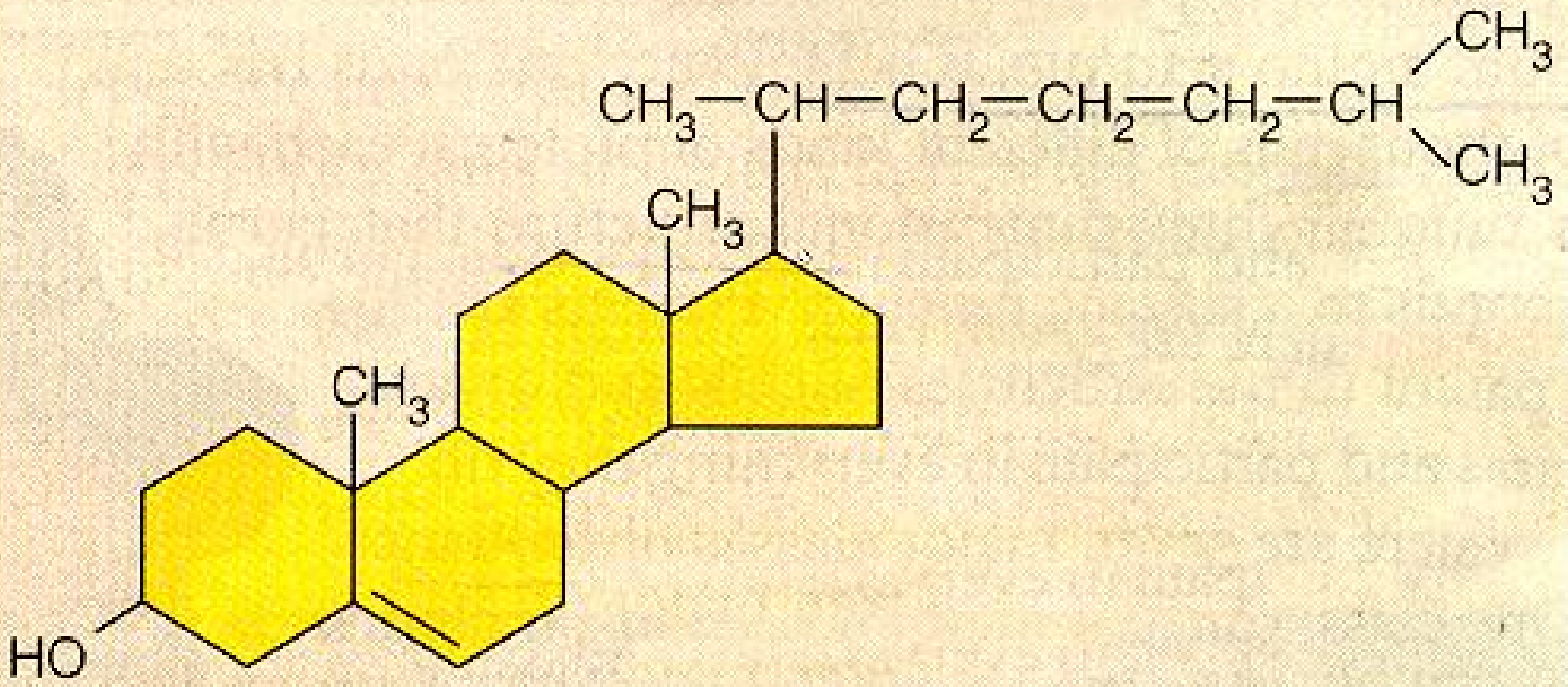



Proteins
Carbohydrate
Lipids

Lipids (cont)

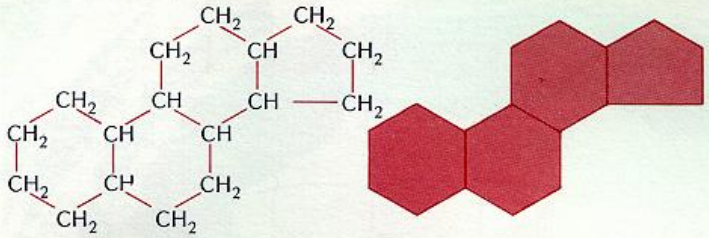
- steriods (carbon skeleton bent to form 4 fused rings)-
  - cholesterol, vitamin D, E, and K, sex hormones
  - carotenes- chemicals used to make vitamin A
  - eiscosanoids
    - prostaglandins- contribute to inflammation, regulate body temperature, help form blood clot
    - leukotrienes- participate in allergic and inflammatory reactions

Cholesterol



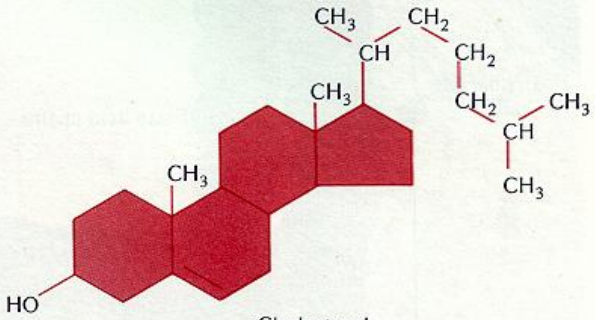
- A constituent of all animal fats and oils

- Cholesterol is one of a group of compounds known as sterols and is related to such other sterols as the sex hormones and the hormones of the adrenal cortex.



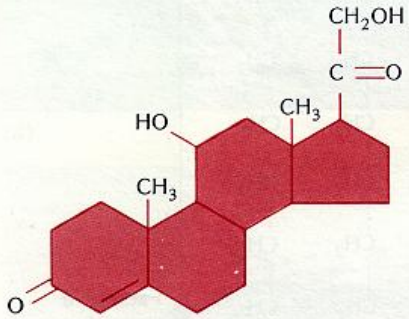
Steroid ring structure

(a)



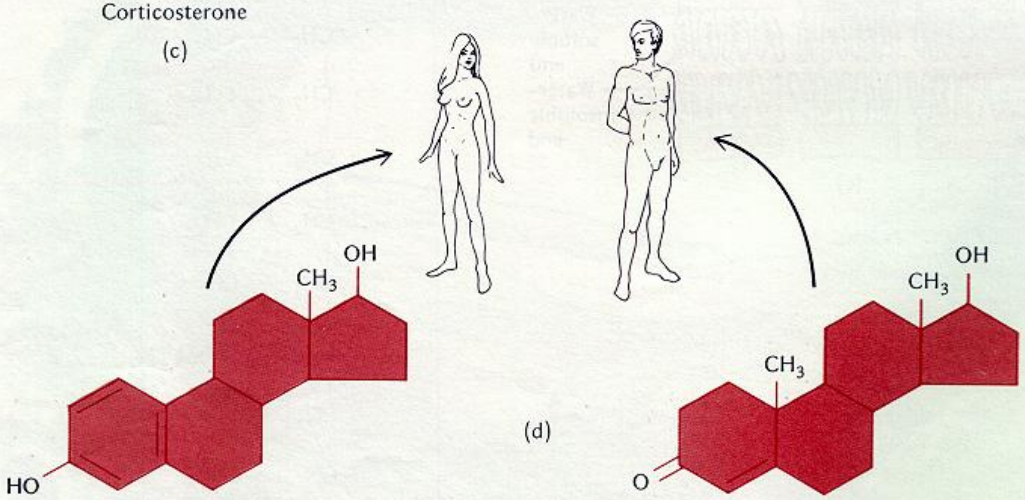
Cholesterol

(b)



Corticosterone

(c)



(d)

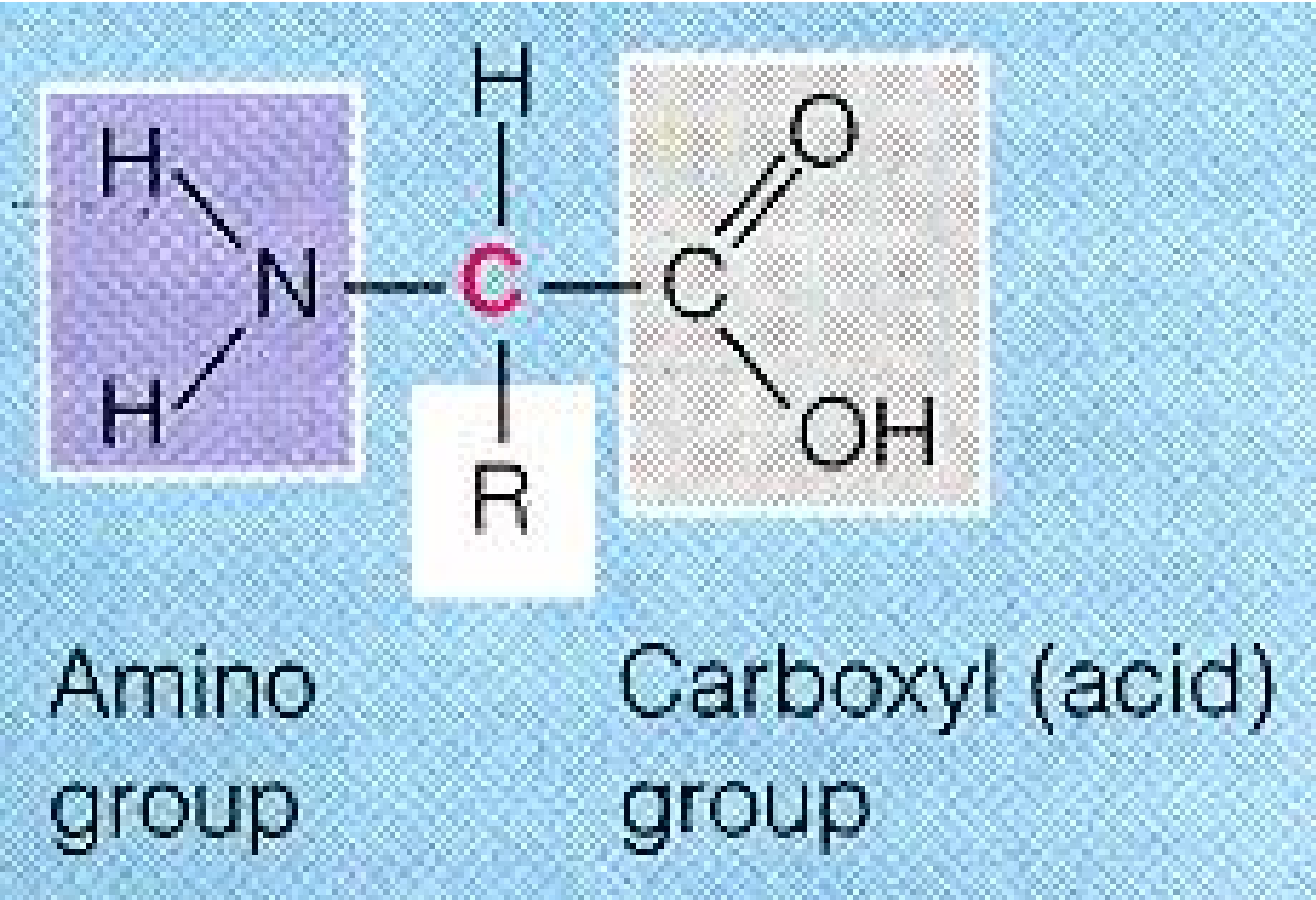
Estrogen (estradiol)

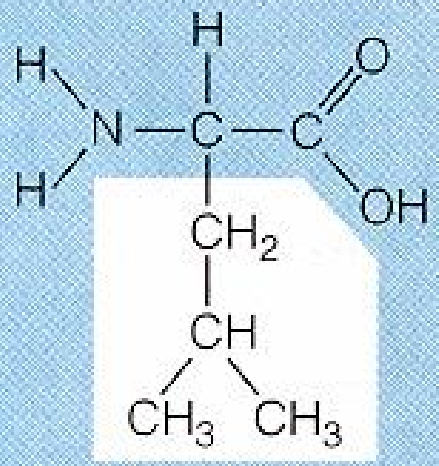
Testosterone

Proteins

- a biological polymer composed of amino acid monomers
- major classes of proteins
  - structural- hair, silk of spiders, fibers that of tendons
  - contractile- provide muscular movement
  - defensive- antibodies which fight infection
  - transport- hemoglobin which carries oxygen
  - hormones
  - enzymes- serves as a chemical catalyst (an agent that changes the rate of a chemical reaction without being changed into a different molecule in the process.
    - Promote and regulate all the chemical reactions in the body

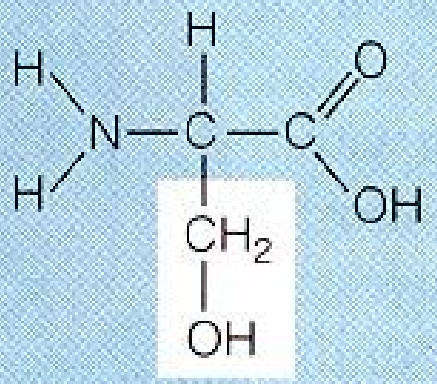
General Structure of an Amino Acid



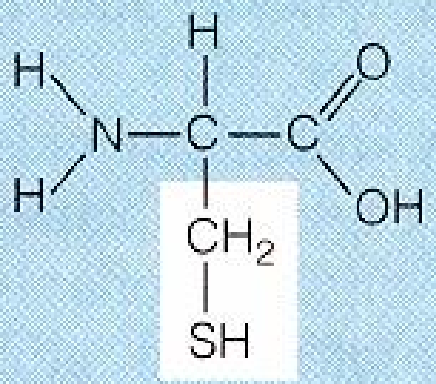


Leucine (Leu)

HYDROPHOBIC



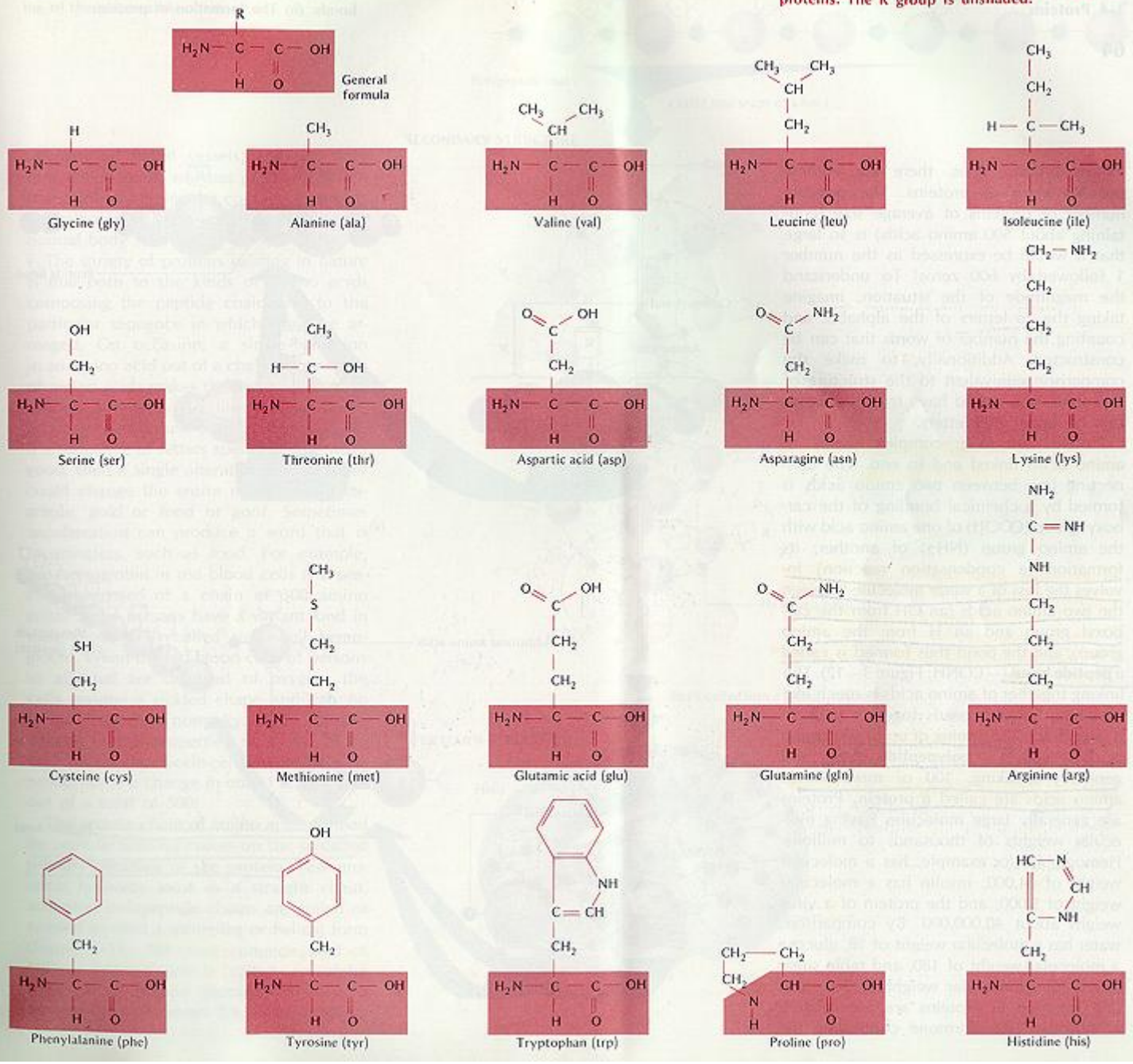
Serine (Ser)

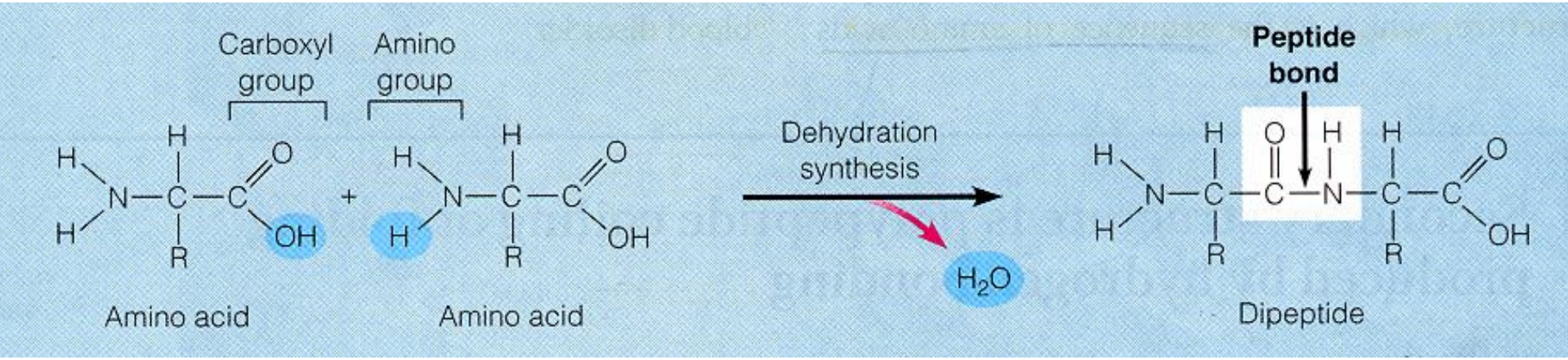


Cysteine (Cys)

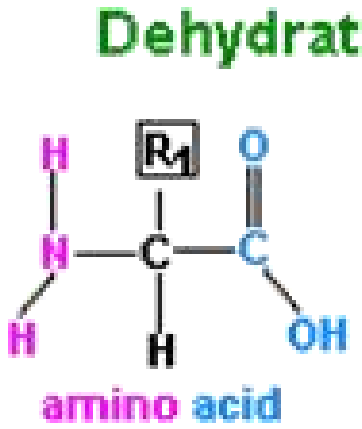
HYDROPHILIC

FIGURE 3–11 The 20 amino acids found in proteins. The R group is unshaded.

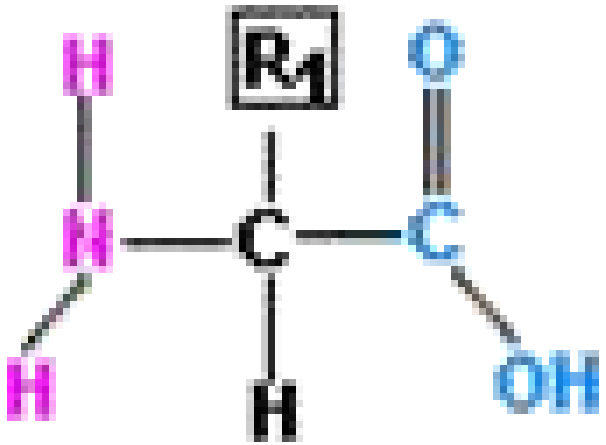




Dipeptide, Tripeptide, Polypeptide

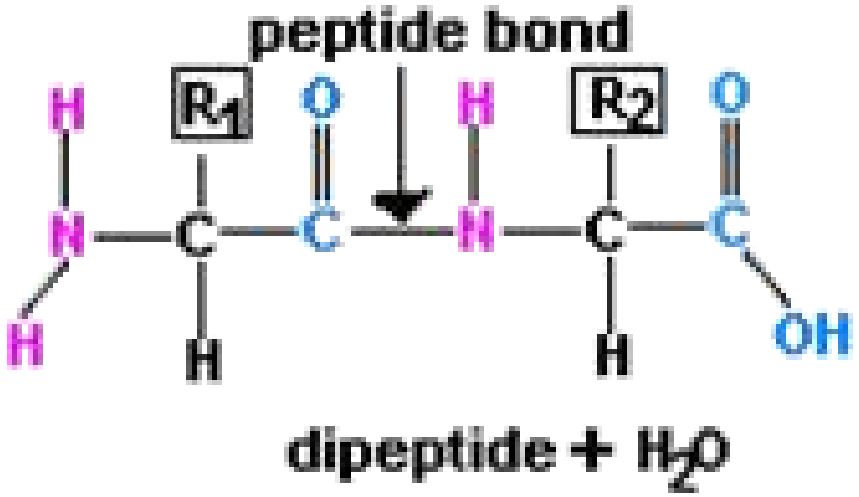


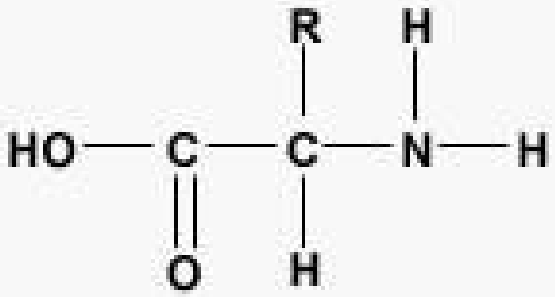
Dehydration Synthesis



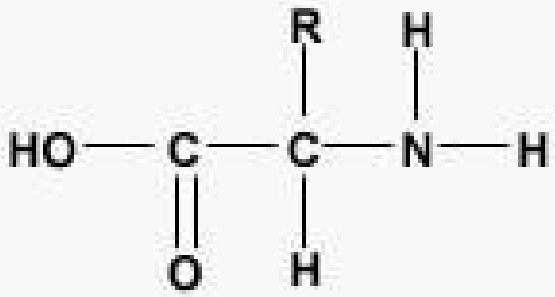
amino acid

Hydrolysis



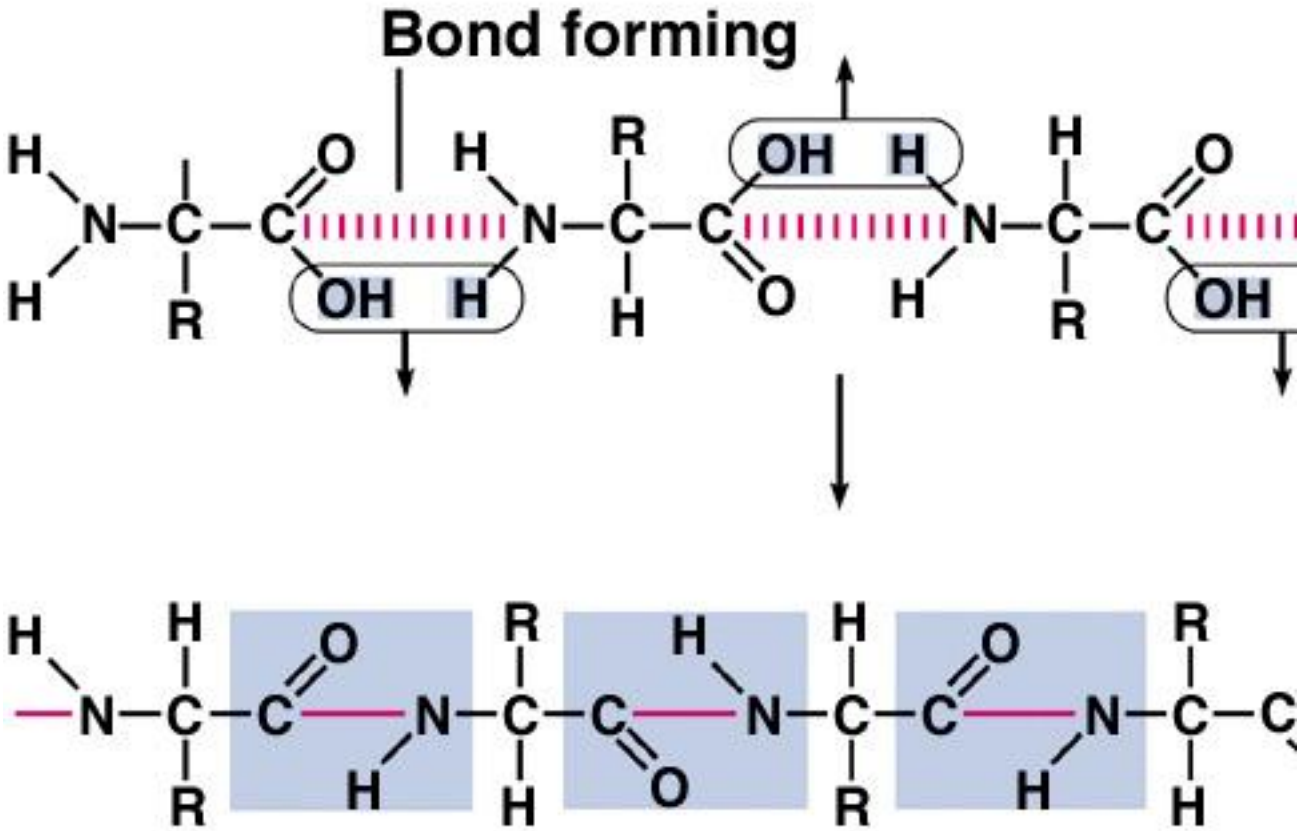


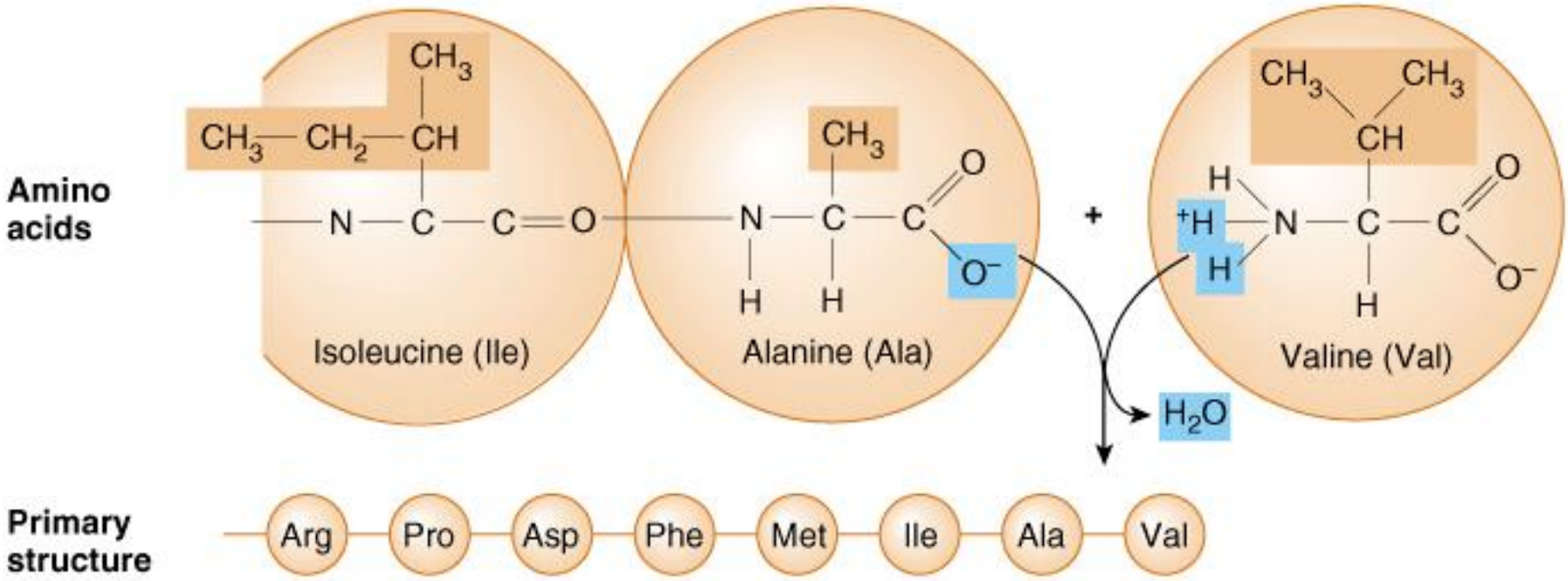
amino acid



amino acid

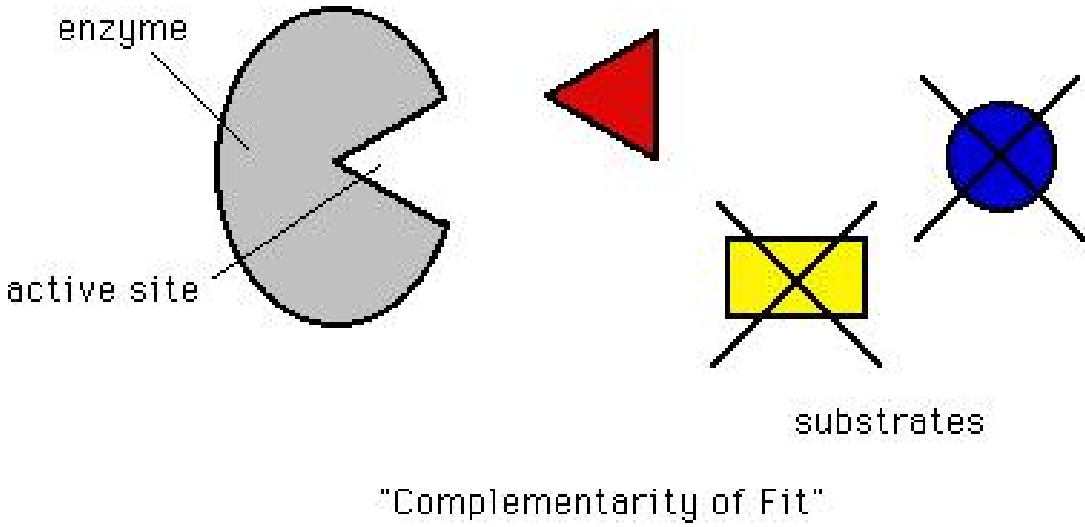
Formation of peptide bond

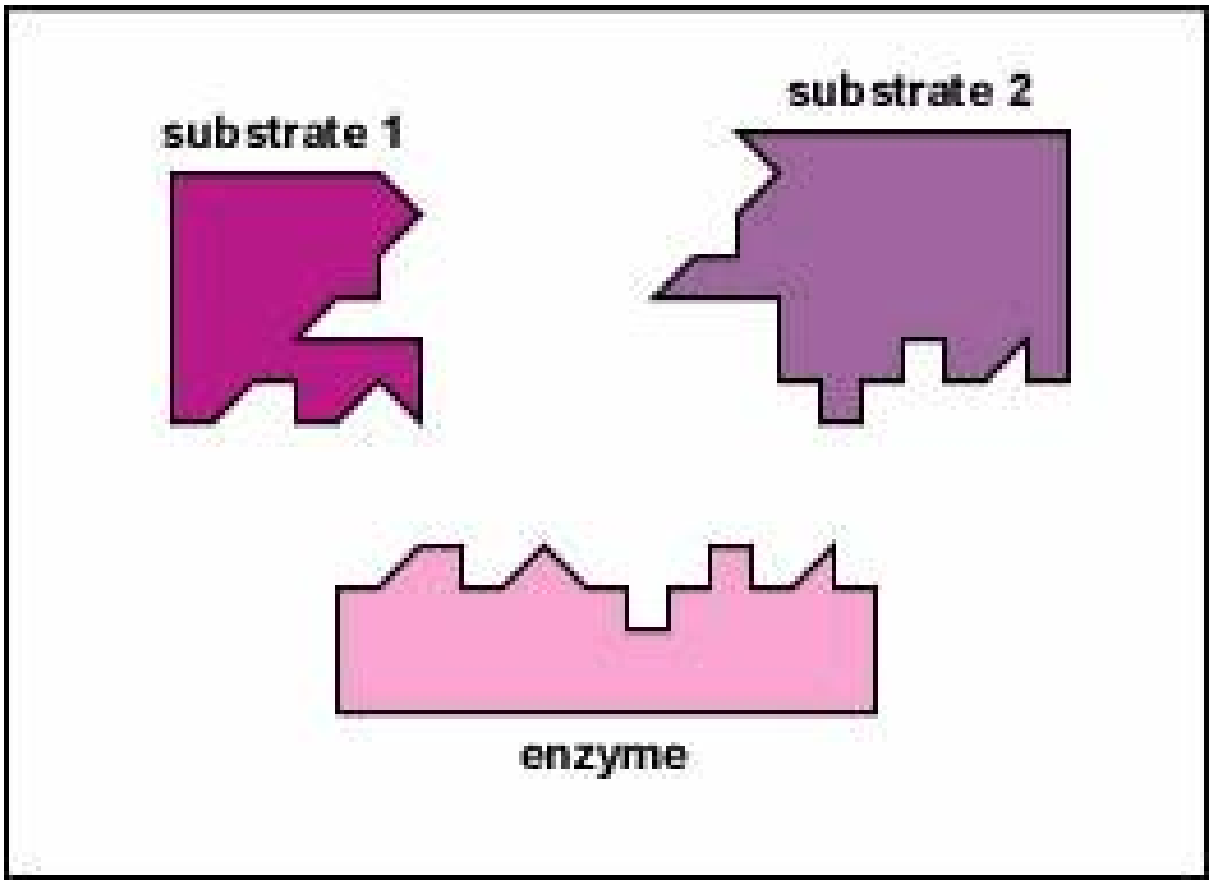




A Protein's Specific Shape Determines its Function

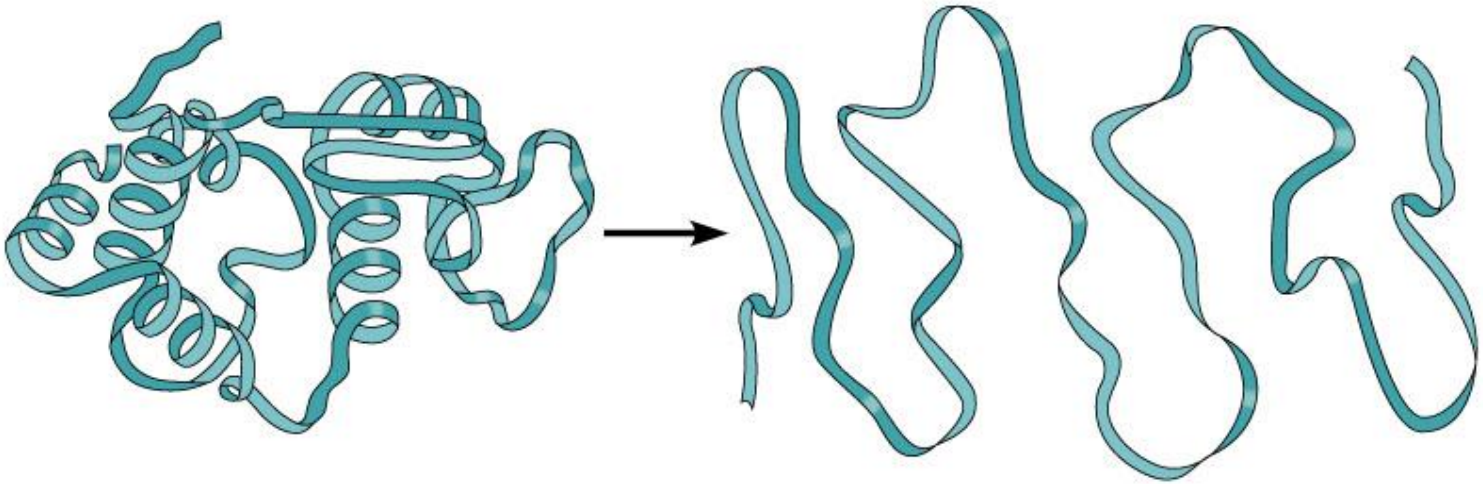
- a protein consist of one or more protein chains folded into a unique shape
- a proteins specificity is dependent on its shape
- most proteins are globular, although structural proteins are long and thin (fibrous)



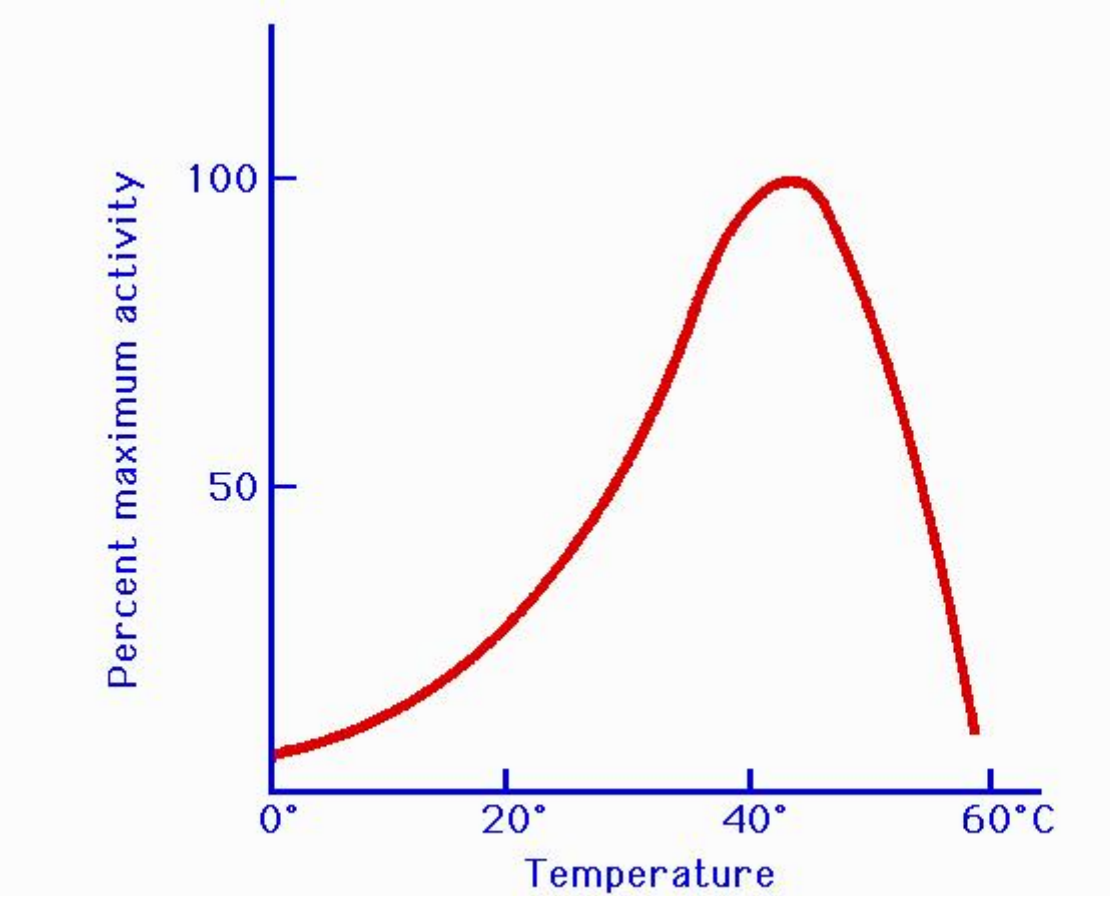

substrate 1
substrate 2
enzyme

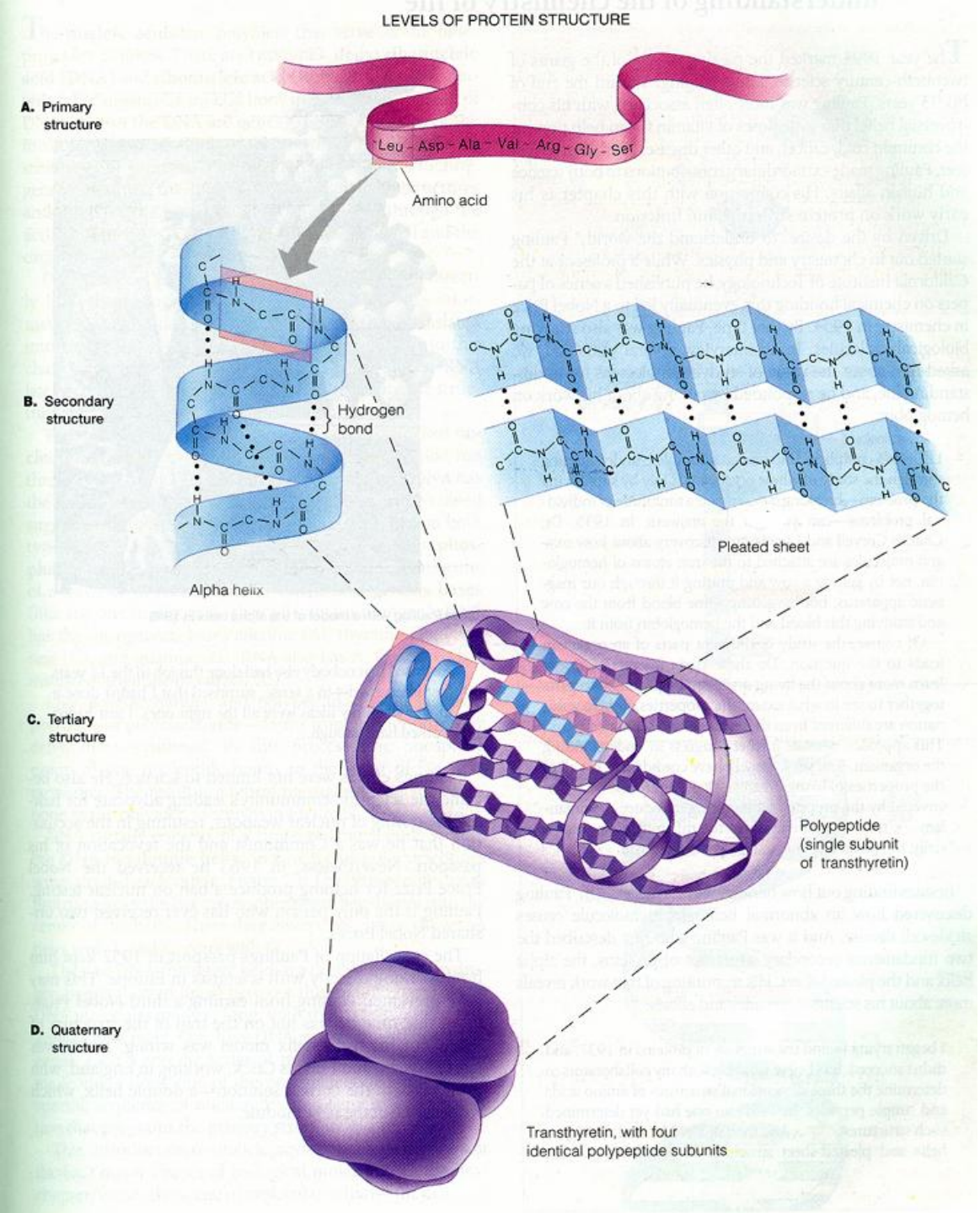
Denaturation

- the process that alters the three dimensional structure
  - heat
  - salt
  - pH



Temperature and Enzyme Activity





Primary Structure- the sequence of amino acids.

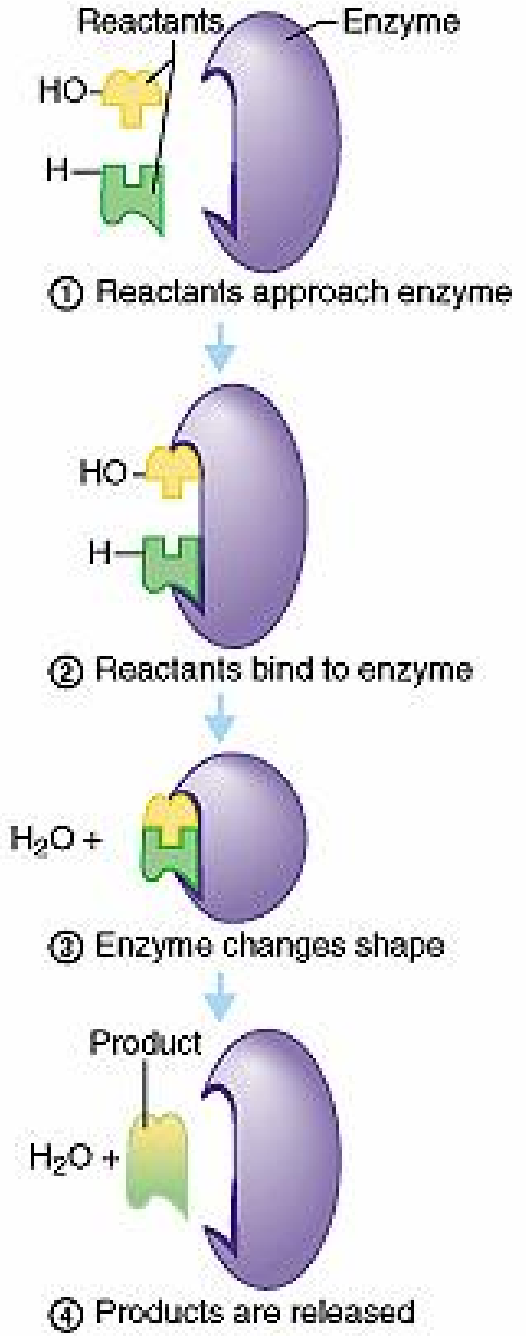
Secondary Structure- parts of the polypeptide which are coiled or folded into local patterns.

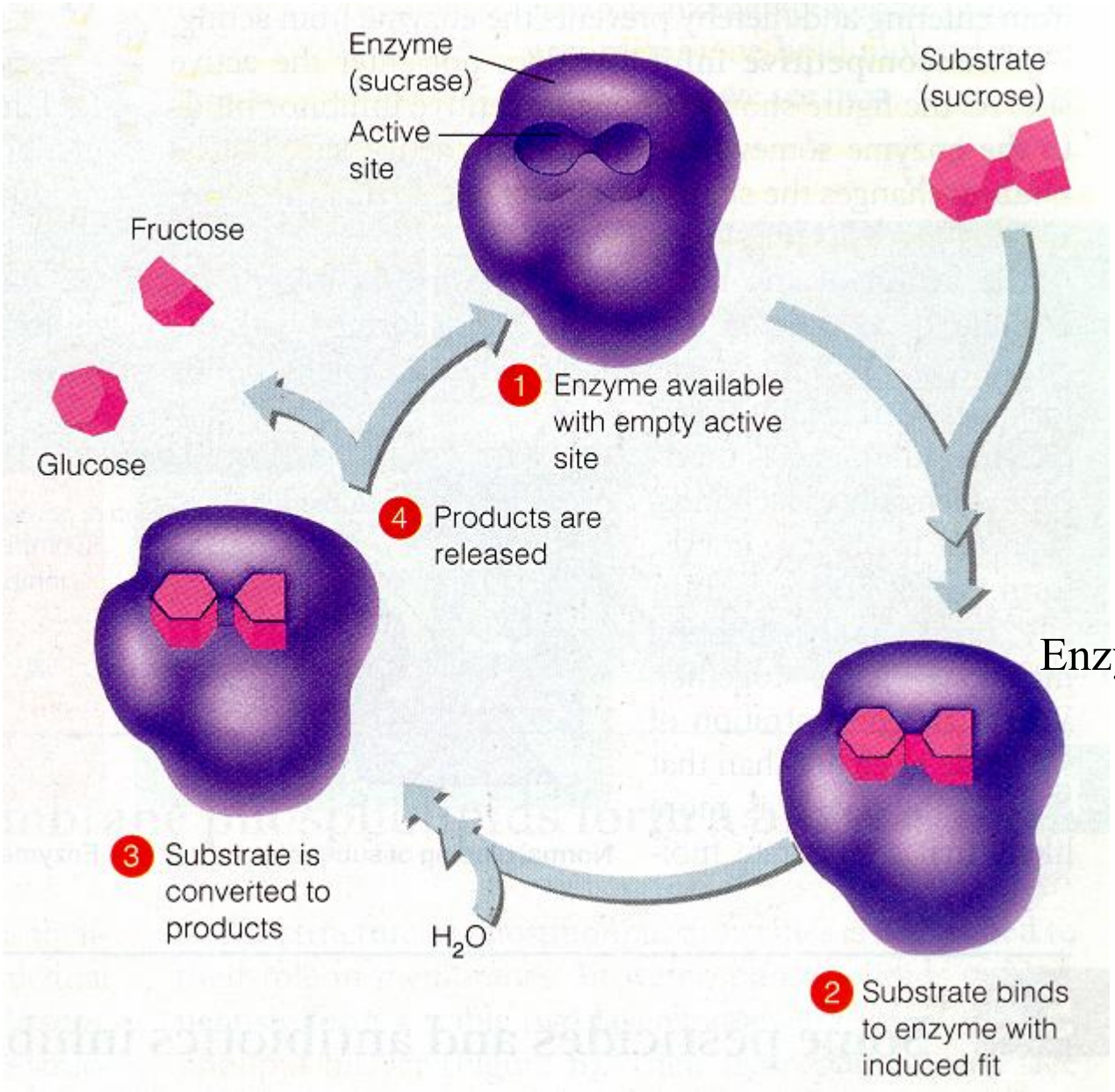
Tertiary Structure- the overall three dimensional shape.

Quaternary Structure- consist of two or more polypeptide chains or subunits.

Enzymes

- Catalyst- Substances that speed up chemical reactions by increasing the frequency of collisions and properly orienting the molecules, without themselves being altered.
- Characteristics
  - Specificity
    - each enzyme has a special substrate
    - active site
  - Efficiency-the number of reactions that can occur per minute (turnover number)
  - Control- the rate of synthesis can be altered by cellular mechanisms.





Enzyme-Substrate complex

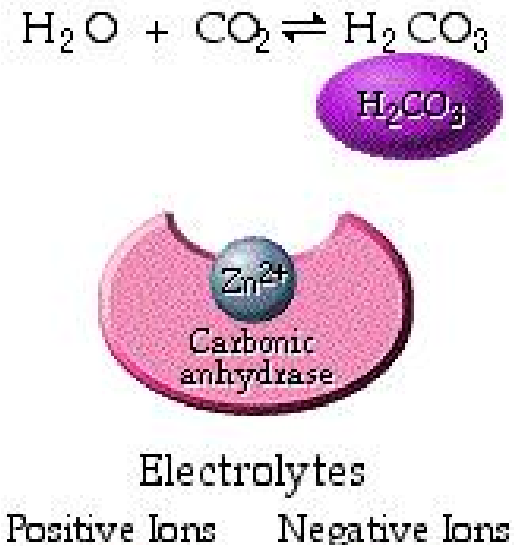
Electrolytes as Cofactors

Non-organic partner that activates the enzyme

1. **Cofactors** for **enzymes**

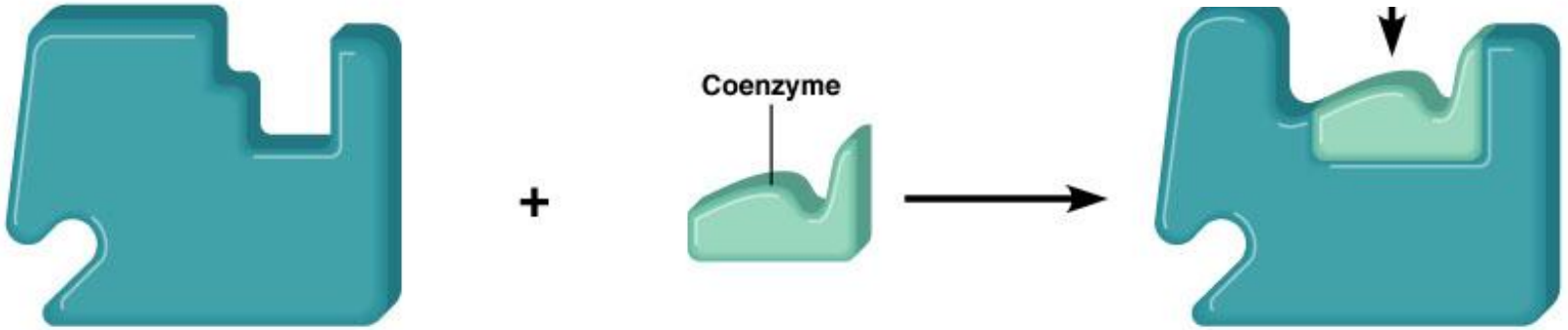
Cofactors act, along with enzymes, to speed up reactions in the body. Ca^{2+}, Mg^{2+}, and other cations such as Zn^{2+} can serve as cofactors for enzymes.

Many other enzymes in the body require positive metal ions as cofactors in order to function.



Electrolytes

Positive Ions Negative Ions



Coenzymes

- **Organic cofactors** that are usually derived from niacin, riboflavin, and other water-soluble vitamins
- They are electron acceptors and transporters

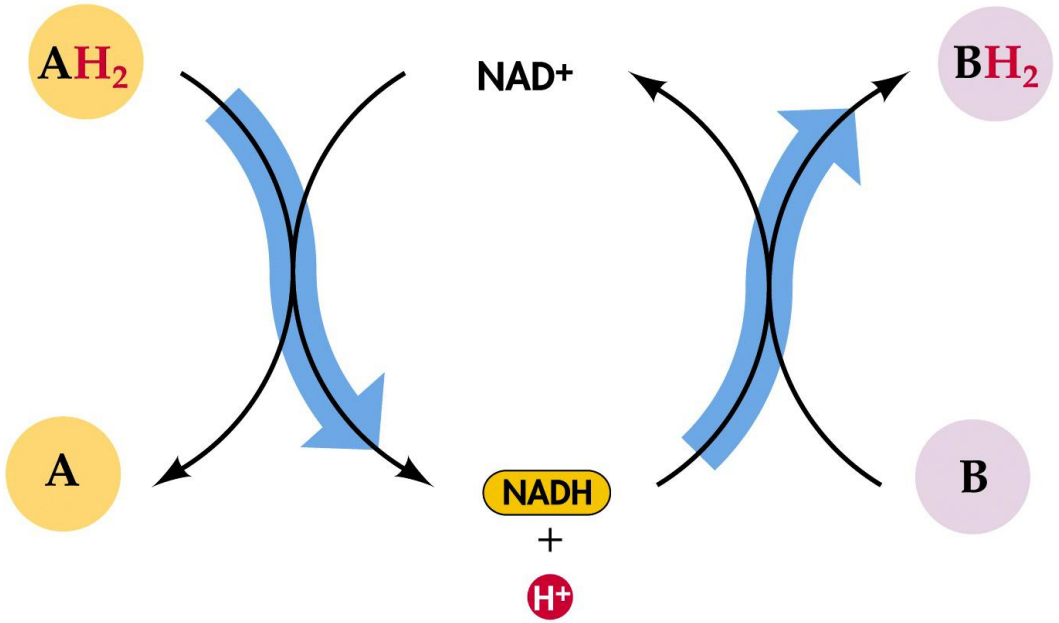


TABLE 5.2 Selected Vitamins and Their Coenzymatic Functions

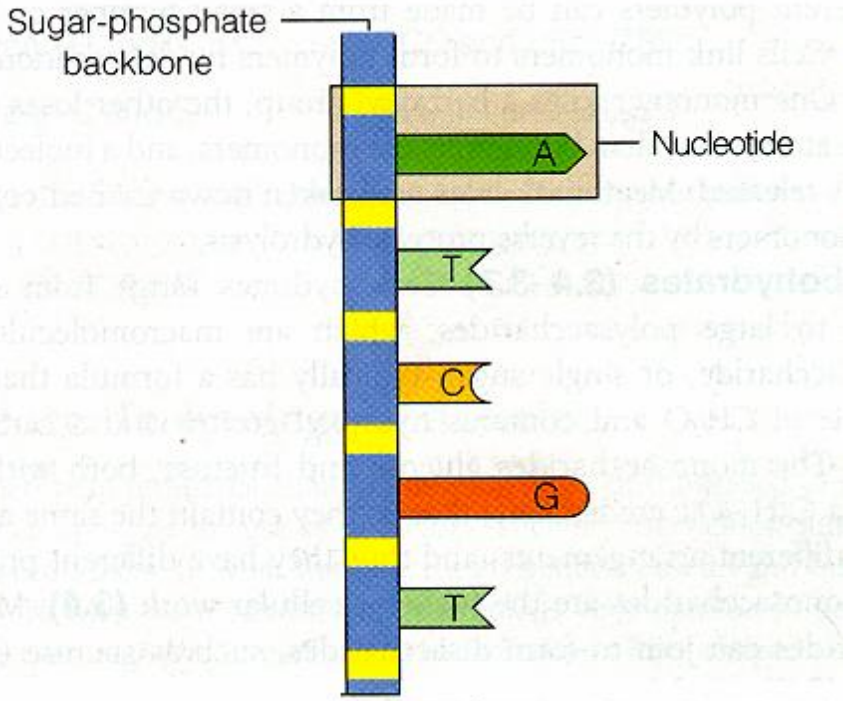
Vitamin	Function
Vitamin B_1 (thiamine)	Part of coenzyme cocarboxylase; has many functions, including the metabolism of pyruvic acid
Vitamin B_2 (riboflavin)	Coenzyme in flavoproteins; active in electron transfers
Niacin (nicotinic acid)	Part of NAD molecule; active in electron transfers
Vitamin B_6 (pyridoxine)	Coenzyme in amino acid metabolism
Vitamin B_{12} (cyanocobalamin)	Coenzyme (methyl cyanocobalamide) involved in the transfer of methyl groups; active in amino acid metabolism
Pantothenic acid	Part of coenzyme A molecule; involved in the metabolism of pyruvic acid and lipids
Biotin	Involved in carbon dioxide fixation reactions and fatty acid synthesis
Folic acid	Coenzyme used in the synthesis of purines and pyrimidines
Vitamin E	Needed for cellular and macromolecular syntheses
Vitamin K	Coenzyme used in electron transport (naphthoquinones and quinones)

Enzyme Classification

- The names of enzymes usually end in the suffix -ase
- Enzymes are grouped according to the types of chemical reactions they catalyze.
  - oxidases- add oxygen
  - dehydrogenases- remove hydrogen
  - hydrolases- add water
  - transferases- transfer groups of atoms

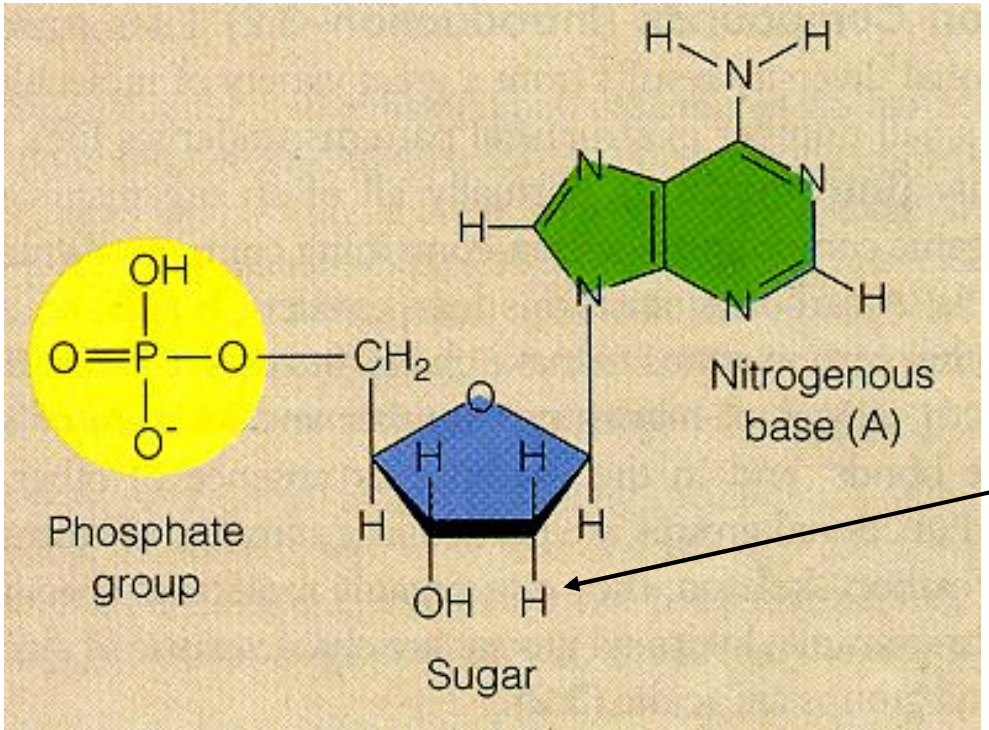
Nucleic Acids

- Polymers of monomers called nucleotides
- serves as blueprint for protein synthesis
- two types of nucleitides
  - DNA (deoxyribonucleic acid)
    - contains all the inheritable genetic information (genes)
  - RNA (ribonucleic acid)



Nucleotide

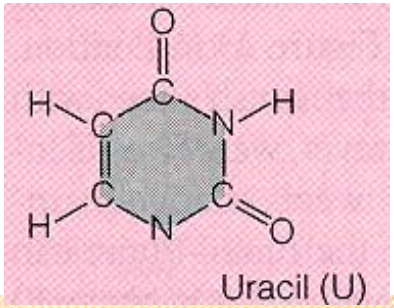
- each nucleotide has three parts
  - sugar- ribose (5C sugar) or deoxyribose
  - phosphate group- constant
  - nitrogenous base- variable

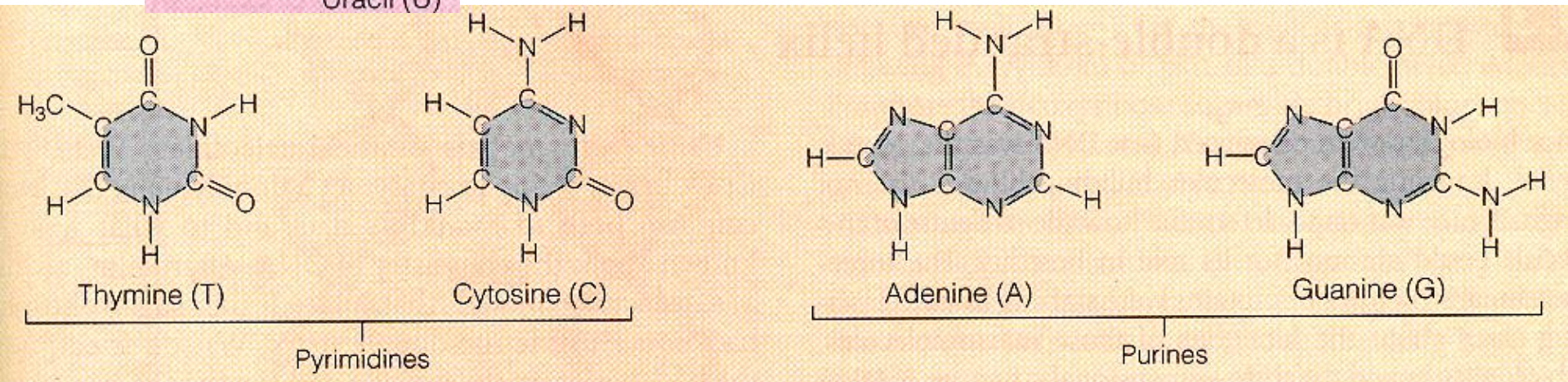


Nucleotides (cont.)

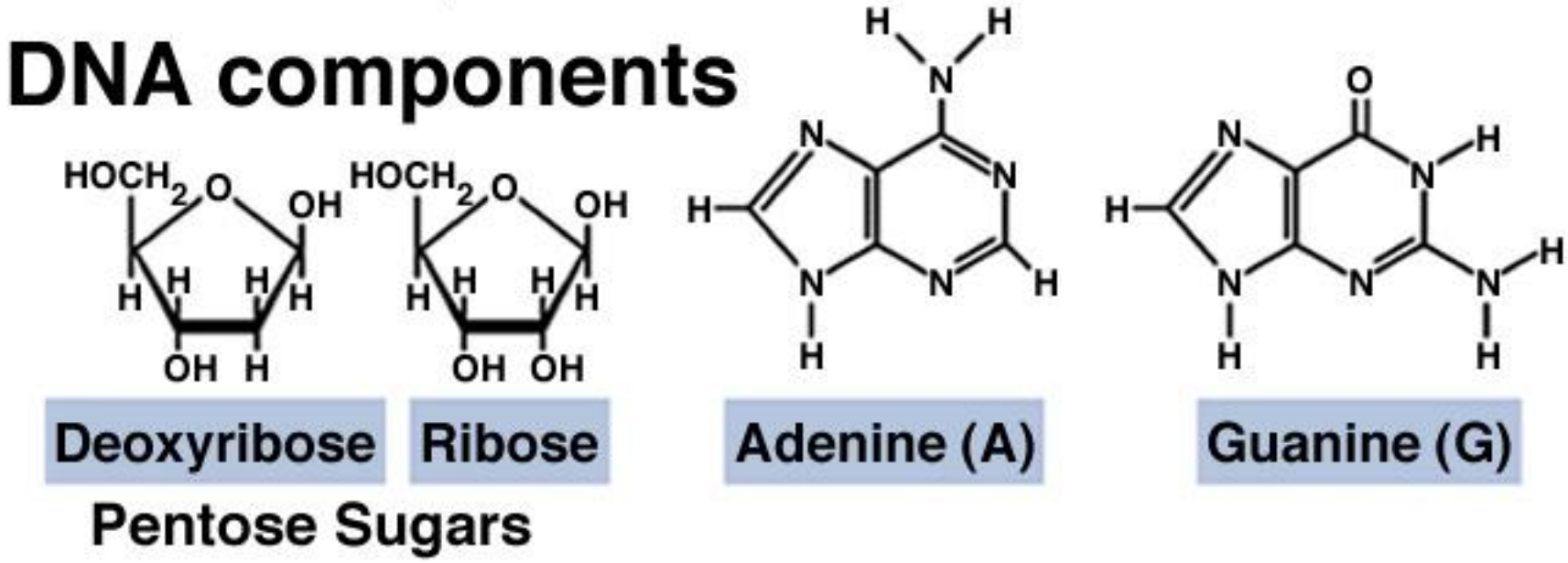
5 different kinds of bases in class into two goups

- Purines
  - adenine, guanine
- Pyrimidines
  - thymine, cytocine, uracis

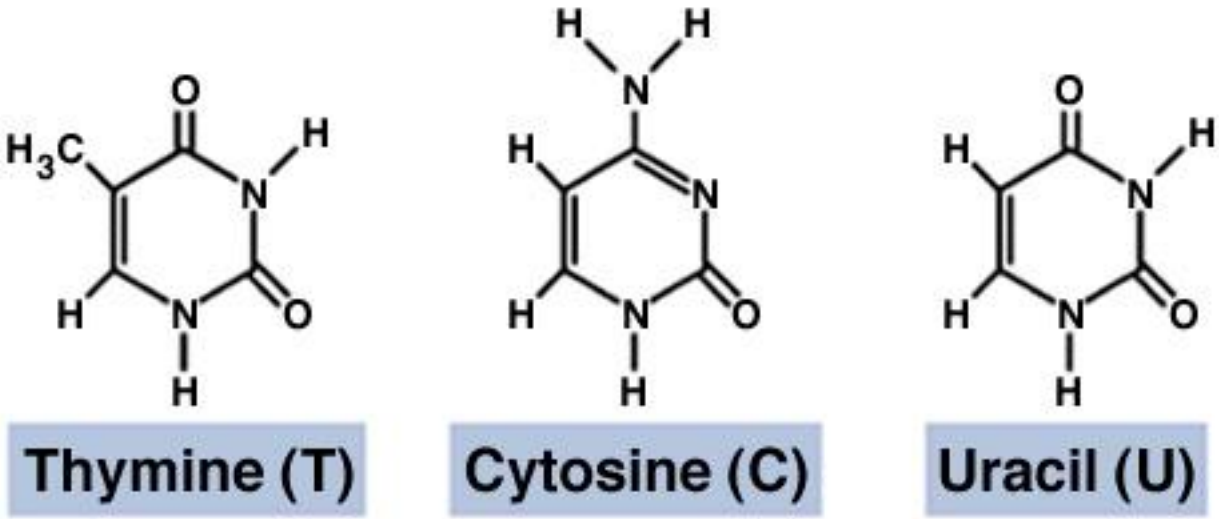




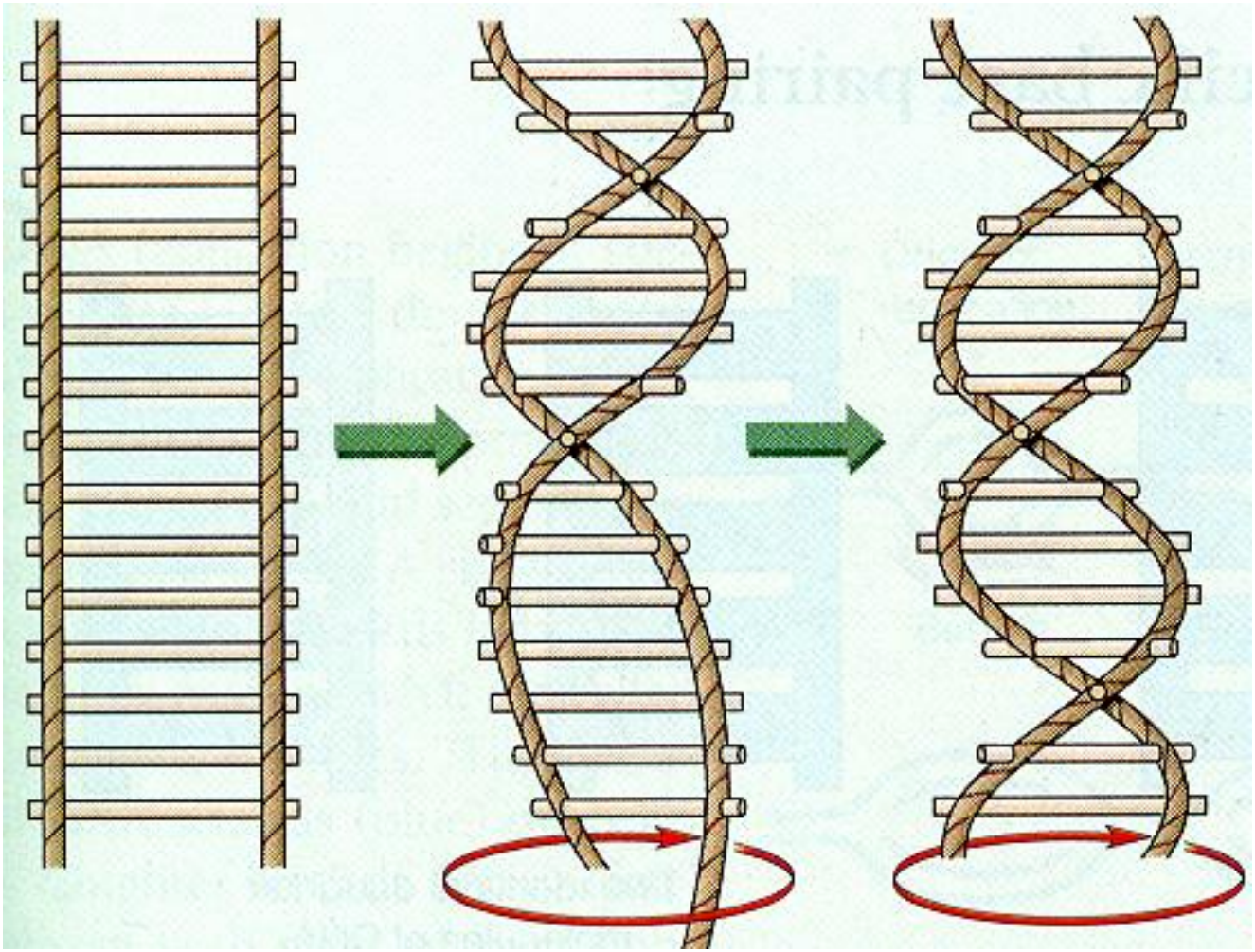
Nucleotides (Cont.)



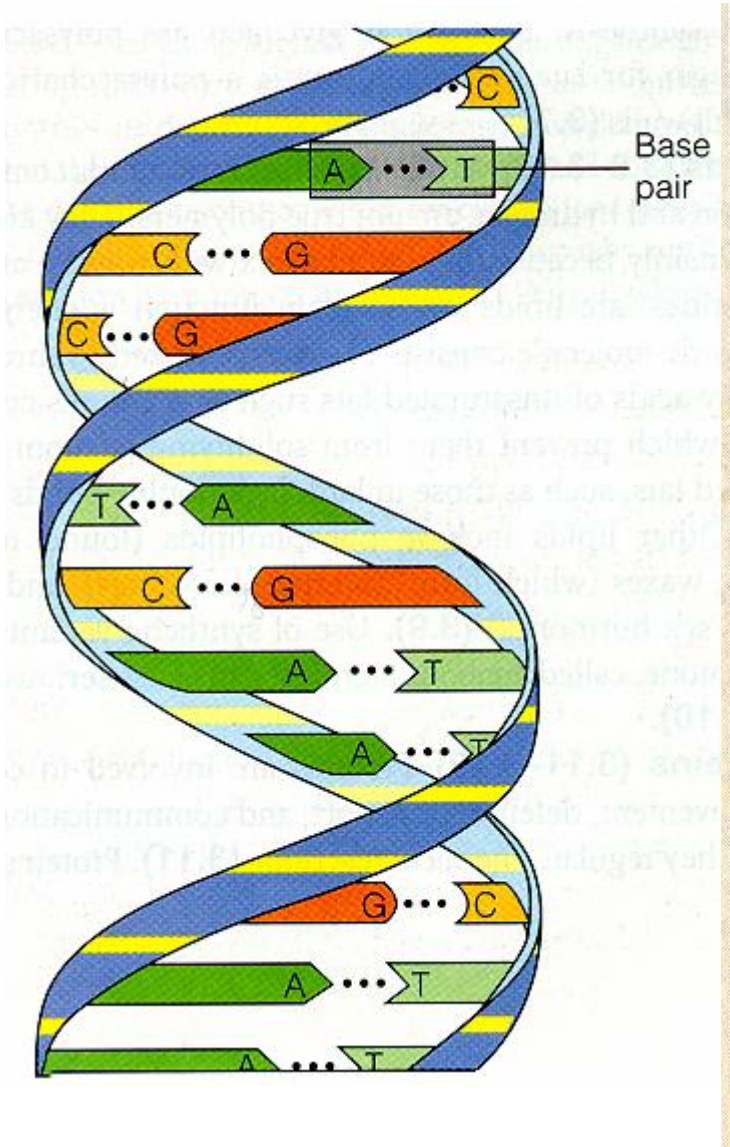
- DNA- A, G, C, T
- RNA- A, G, C, U

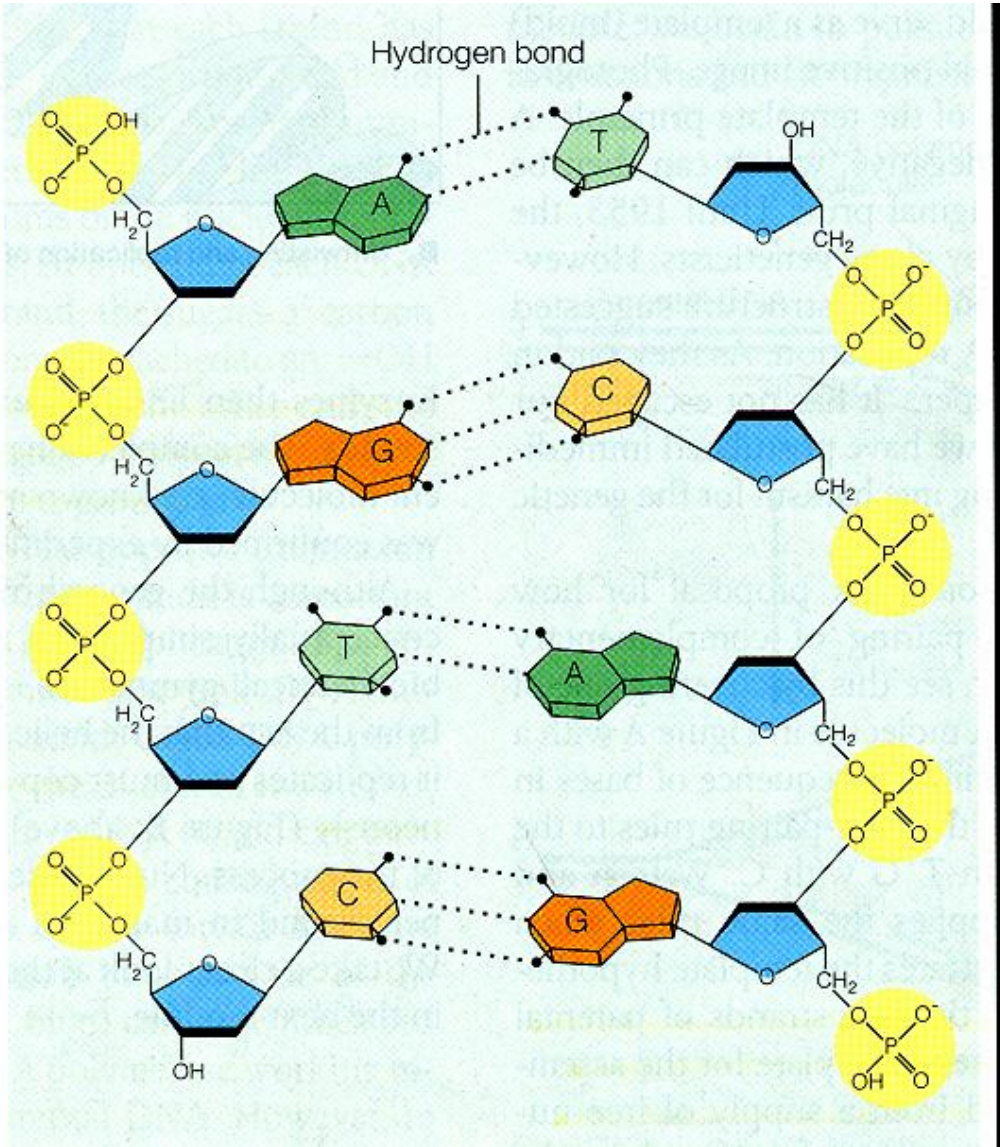


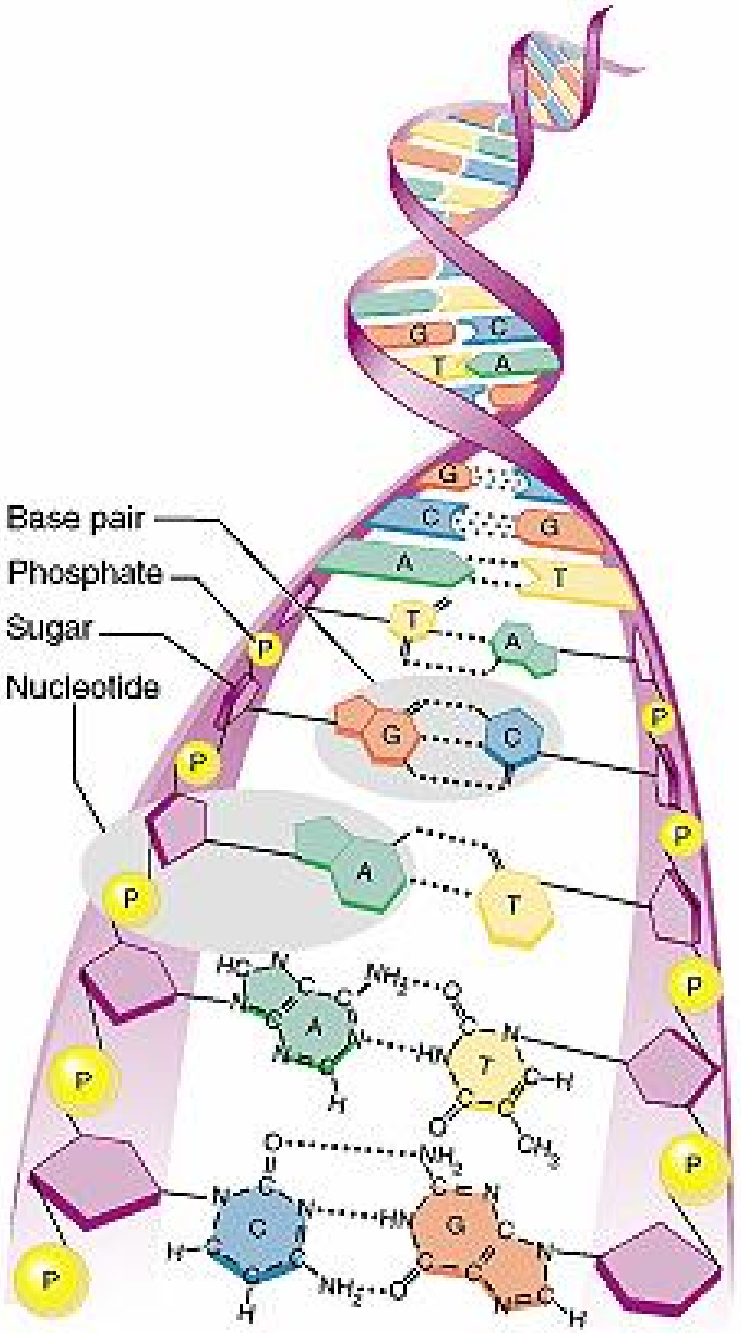
Double Stranded DNA



DNA Strand With Complimentary Base Paring

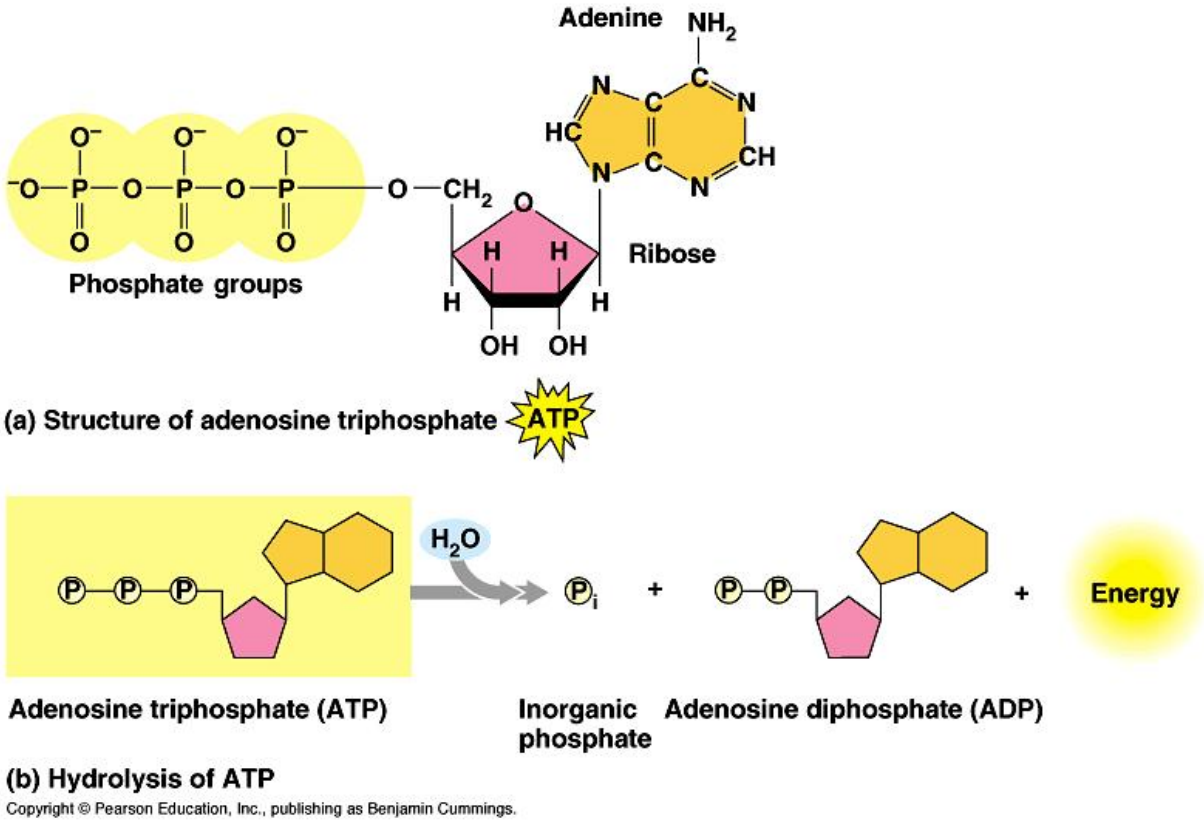


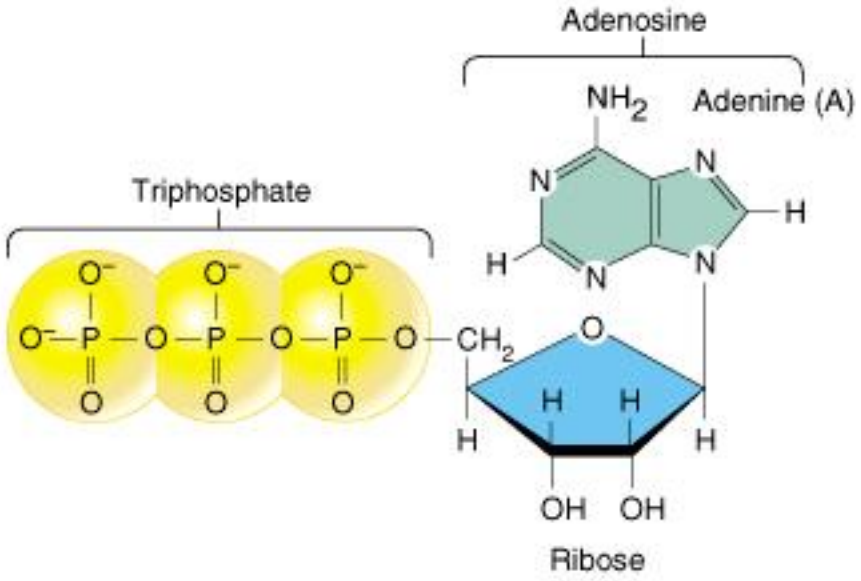




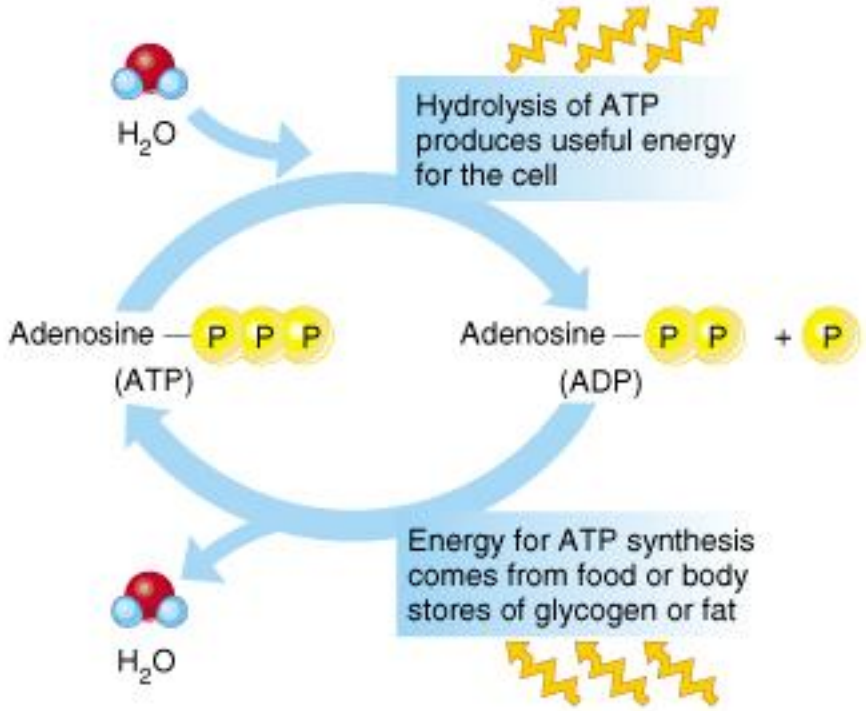
ATP

- The bodies most important energy transfer molecule
- Energy is in the phosphate bonds
- Bonds hydrolyzed by adenosine triphosphatases (ATPases)
- Much of the energy in ATP comes form glucose oxidation



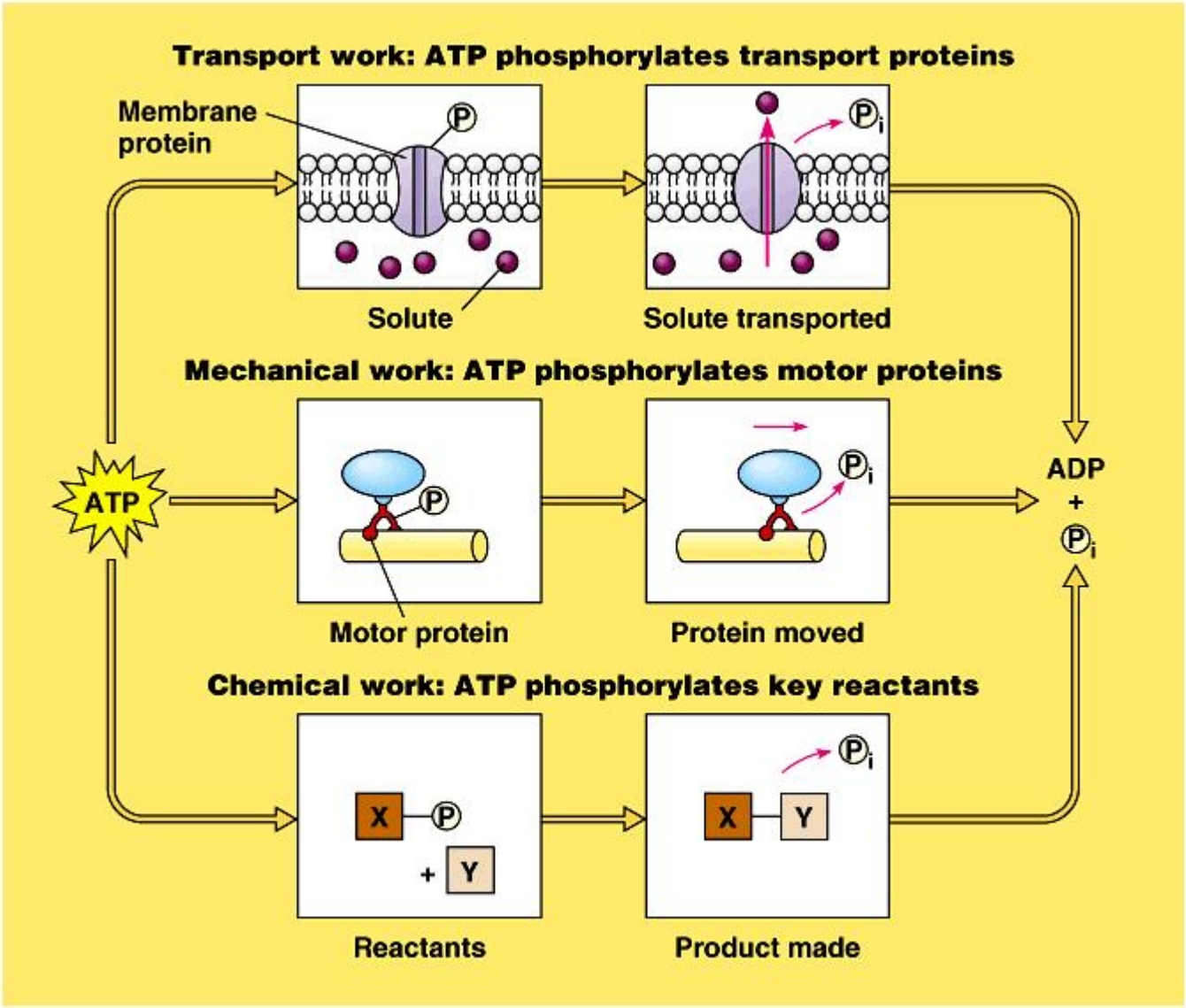


(a)



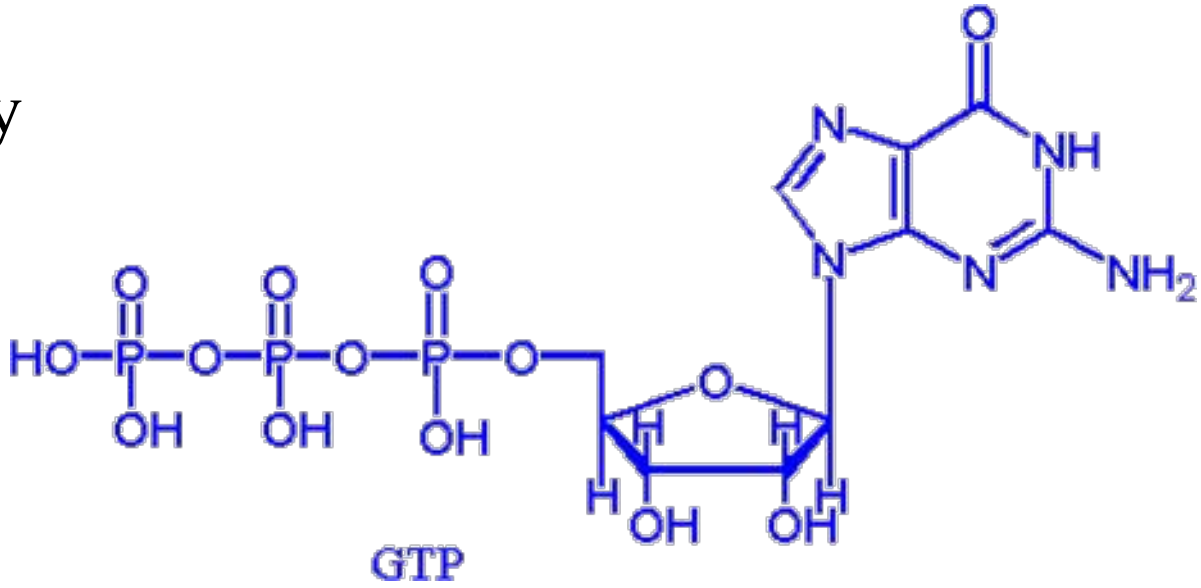
(b)

Phosphorylation by Kinases



Guanosine Triphosphate (GTP)

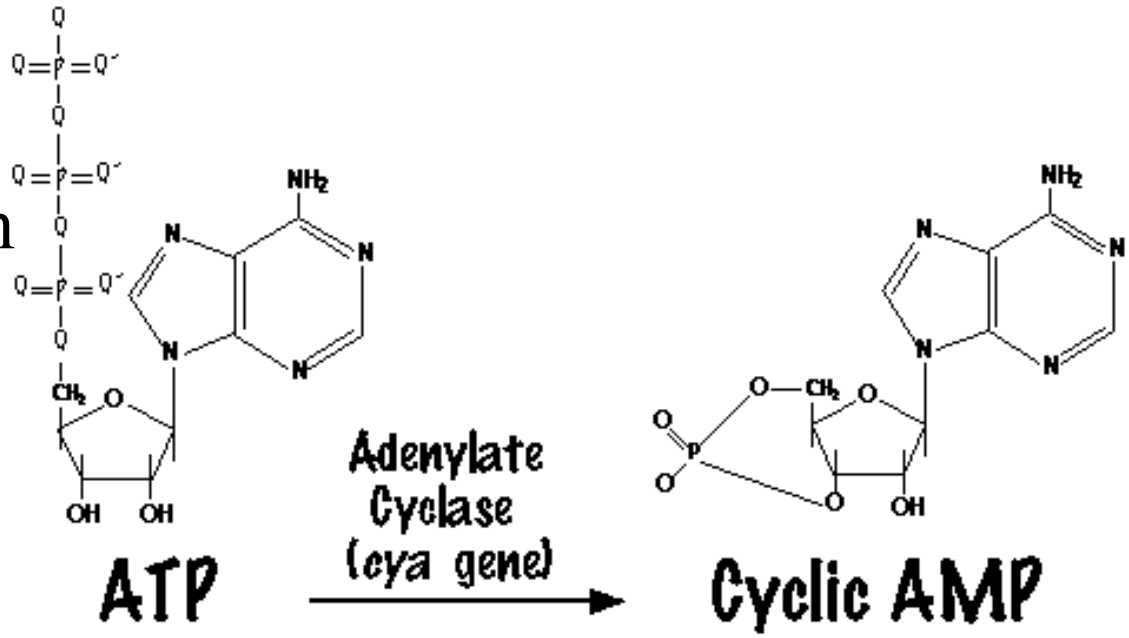
- Nucleotide involved in energy transfer
- Activates the G protein in cell signaling

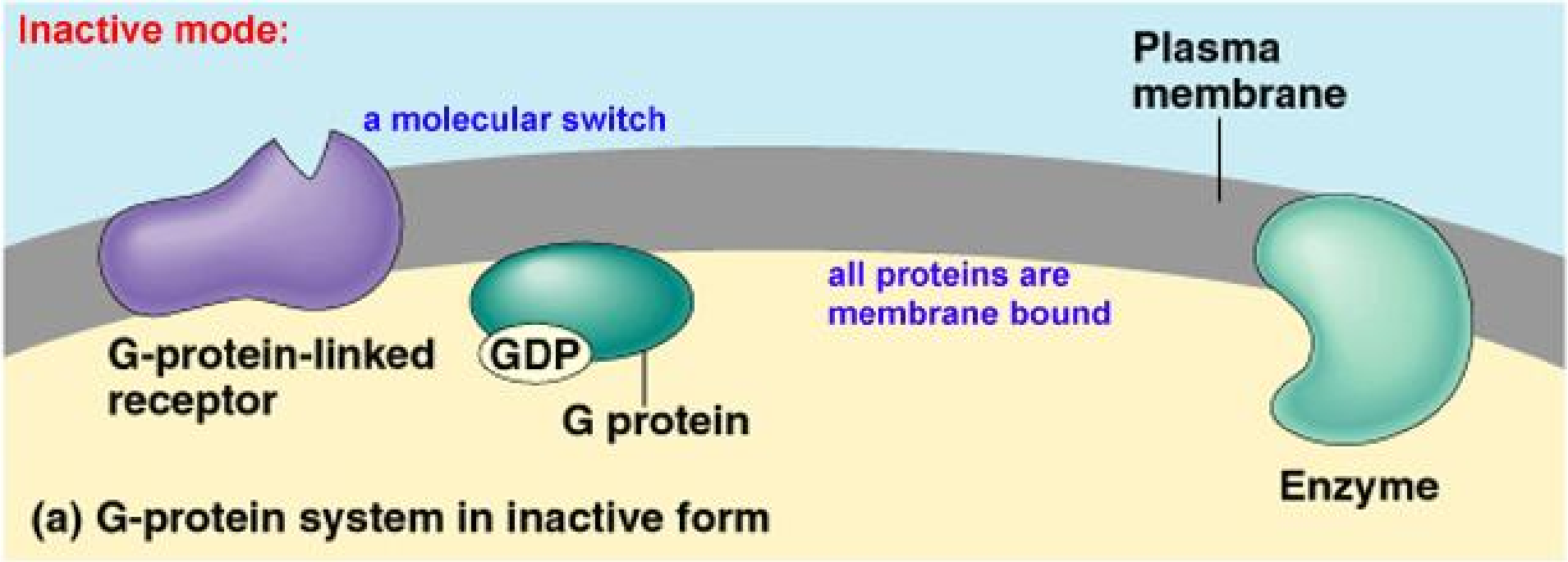


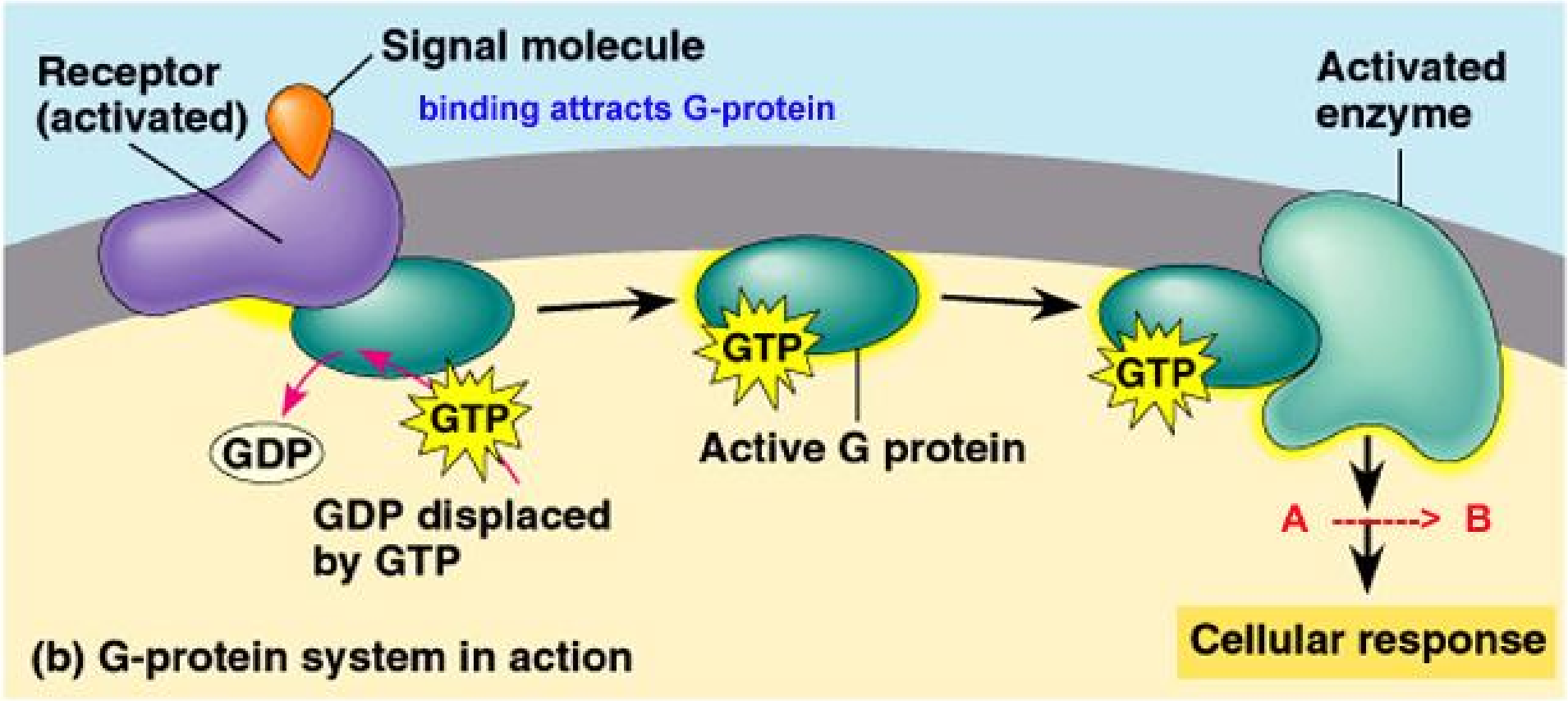
GTP

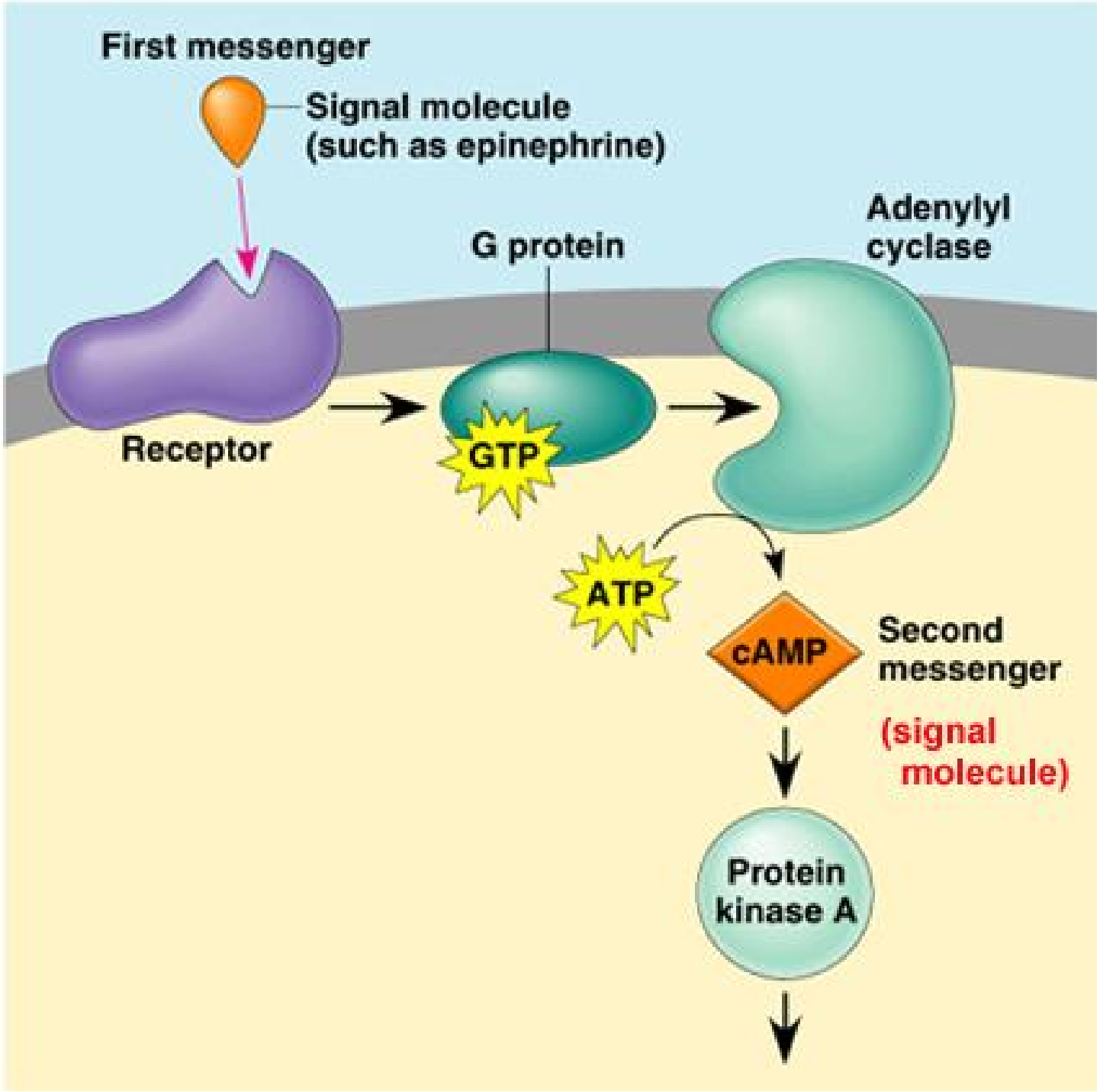
Cyclic AMP (cAMP)

- Formed from the removal of both second and third phosphate groups from ATP
- Acts as second messenger to activate metabolic effects within the cell




Inactive mode:
Plasma membrane
a molecular switch
all proteins are membrane bound
G-protein-linked receptor
GDP
G protein
Enzyme
(a) G-protein system in inactive form


Receptor
(activated)
Signal molecule
binding attracts G-protein
Activated
enzyme
GTP
GDP
GTP
GTP
Active G protein
A ----> B
GDP displaced
by GTP
Cellular response
(b) G-protein system in action


First messenger
Signal molecule
(such as epinephrine)
G protein
Adenylyl
cyclase
Receptor
GTP
ATP
cAMP
Second
messenger
(signal
molecule)
Protein
kinase A